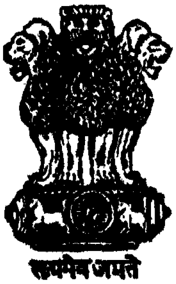

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Development of Natural Resources:
The Coming Technological Revolution on the Land

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PRODUCTIVE LAND IS UNLIKE ANY other natural resource. It is characterized by the element of life placed by Nature in the thin mantle of fruitful soil occurring over a limited portion of the earth's surface. It is this life-producing quality that makes some lands productive, and it is the absence of this quality that makes some barren.

Productive land is further differentiated from other natural resources in that it must be maintained and used simultaneously; that is, it must be kept intact while in use. All other natural resources, with very few exceptions, must be taken from the earth—separated from it—in order to be used by man. The exceptions are certain forms of wildlife and those natural areas which, because of their aesthetic values, are kept in their original state.

Productive land is much more limited than commonly has been supposed. It occurs only on the surface of the earth, and only on part of this surface. It is not permanent. Once the fertile topsoil is washed or blown away, it cannot be restored or replaced in any practical way for generations. And what is left—subsoil—usually is far less productive, or sterile, and less stable. There are no undiscovered reserves of productive land of any substantial area.

We cannot dig deeper into the earth and find new productive soil. We cannot pump it from wells, plant it with seeds, or dig it from mines. We must keep what we have or do without. Assorted residues of sand and gravel left stranded along streamways are of small value.

Productive land is the only natural resource without which we cannot live. We are completely dependent on it for the food we eat, except fish. We also depend on it for a very large share of our clothing and shelter. We cannot get enough to feed ourselves or provide our clothing from the oceans. On any large scale, hydroponics would be utterly impractical. We might conceivably turn sometime to some form of synthetic food, as pills, plus a roughage, but this appears to be a fantastic extreme, still far away, and likely, if it ever comes, it will be decidedly unpopular.

There is no doubt about the need for protecting productive land. Year after year, for generations, man has been steadily engaged in ruining millions and million of acres of this basic resource. Every hard rain falling on unprotected, cultivated, or overgrazed sloping land washes additional tons of soil downslope, downstream, into the rivers, reservoirs, and oceans. There is no practical way of bringing this back. And every hard wind, blowing across bare, dry soil, whether sloping or level, adds to the damage. Wind lifts the fine soil particles into the air and often develops huge dust storms that destructively scatter the substance of the land. What is left behind, frequently, is infertile, shifting sand that smothers out vegetation on neighboring good land.

When the world was younger and our population much smaller, we could, perhaps, stand such waste, but that time is past. It is not defeatism to say that the world is fast maturing and must assume now a mature responsibility for its resources. It is not limiting the horizons of the future to say that land exploitation must stop. It is simply a matter of common sense and self-preservation. Besides saving soil and water—the two go together—soil conservation results in increased yields per acre. It is also easier and cheaper to farm on the contour than up and down hill.

Today, throughout our world, there are left only about 4,000,000,000 acres of immediately arable land, the productivity of a great deal of which is only fair to medium. Some of it is poor. Yet we must count on all of it to feed a population reported to be in excess of 2,000,000,000, and still increasing.

The United States is somewhat better off, from the standpoint of productive land, than most nations. Even though we have ruined more good land in less time than any other nation in recorded history, we had the advantage of an unprecedented supply to begin with. Now we have little margin left, but we still have enough productive land if we take care of it. We cannot hope to maintain our present standard of living if we lose much more; eventually, if the losses should continue, the Nation would suffer even more seriously.

There are about 460,000,000 acres of really good, high-class cropland left in the United States. This includes, in addition to that now in crops, about 100,000,000 acres that need drainage, irrigation, clearing, or other improvements. All but about 70,000,000 of these 460,000,000 acres of high-grade land is subject to erosion if it is not protected. We have no reason for complacence.

Address given before the Engineering and Human Affairs Conference at the Princeton University Bicentennial Conference, Princeton, New Jersey, October 2, 1946.

Our record shows that we have ruined, for further practical cultivation, about one-fifth of our original area of tillable land. A third of what remains has already been badly damaged, another third is highly vulnerable, and the erosion process is still going on.

How did we get into this predicament? Why was this allowed to happen? Why didn't you hear about it sooner? There are a number of reasons, but probably the following are the main ones:

First, we began losing land to erosion when the world was still young. Those were the days when there was always more land—a great deal more—just over the hill or across the ocean. People came to regard land as limitless and inexhaustible. This deceptive idea persisted as time went by, and it was probably not until the United States was settled all the way to the Pacific Coast that people began to have any real doubts about the myth of land plenty.

Second, the apparent abundance of good land for so many generations gave rise to a careless and prodigal attitude. There was nothing of any compelling nature to cause a landowner to take care of his land or have concern about maintaining its productivity. New land somewhere could almost always be had.

Third, in modern times, the leaders of thought and nations—and nearly everybody else—too often have had little or no personal knowledge or understanding of the land. They have been trained in law, finance, philosophy, administration, military science, economics, education, or some field other than agriculture, and especially that part of agriculture having to do with maintenance of the base, meaning the land. With few exceptions they have had neither the incentive nor the training to look at the landscape around them and understand what was happening. The ancient and unchallenged myth of land plenty came down to them too, through the ages, and was accepted as truth.

Fourth, too much of the land traditionally has been in the hands of the untutored and the inept. In very recent years and in a very few countries, this situation has been changing, fortunately, for the better. However, over most of the world, land is still being used by men with little specialized or adequate training for the job. Too many land users have operated on a trial-and-error basis and have been influenced predominantly by habits handed down from the past, whether good or bad. Some have placed greater faith in superstition than in science. Under the names of peasant, farmer, rustic, and country fellow, these individuals have been synonymous, for generations, with all that is naïve, uneducated, and backward. Possessed frequently of such virtues as thrift and diligence, they have nevertheless often assumed a scornful attitude toward education and the educated, and too often the farm has been the last resort to which men, unsuccessful in other fields, have turned. In short, the most precious natural resource on earth in too many places has habitually been in the charge of those who have had no greater qualifications for the trusteeship than the coincidence of inheritance or birth on the land.

Fifth, too few farms have produced surplus capital for the owner over a period of years. On the contrary, the farm often has been no better than a marginal or subsistence enterprise. Even in the United States, the farmer rarely has had the personal resources to undertake research or seek out technological improvements. He has generally been almost wholly dependent on outside help, from government or private corporation, to provide him with improvements in machinery, materials, and methods.

Sixth, our agricultural scientists failed completely, over bygone years, to recognize land for what it is—an impermanent and complex resource. They considered soil permanent and synonymous with land. As a result of this mistake, both agriculture and the land suffered. Soil is but one part of land. For all practical purposes, land must be regarded in terms of all its component parts of soil, slope, climate, and susceptibility to erosion. The early scientists largely ignored erosion, paid little attention to slope, called the weather inevitable, and took soil samples right and left. In the main, however, agricultural science was not greatly concerned about the land. In large degree it was more interested in the health and breeding of livestock; improvement in strains of grasses, legumes, grains, and fibers; and modernization of machinery and equipment. All of this was beneficial, but it did neglect the capital stock of agriculture and the source of production—the land itself.

Seventh, in agriculture as in other enterprises we often wait until we are sick before we call the doctor. There is an element of human nature about this, and it has operated on the land. We did not practice preventive medicine, and now we must try to cure a malady —erosion—that has gotten into our system and weakened us.

So much for history. There is little to be gained by a review of past shortcomings except as it will help us avoid similar pitfalls in the future. Today we are profiting from the lessons of the past. We know now:

(1) That productive land is neither limitless nor inexhaustible. On the contrary, we have learned that the area of productive land is steadily shrinking before the onslaught of erosion.

(2) That land must be expertly cared for if it is to be maintained in a productive state.

(3) That productive land must assume an ever more prominent position in the thinking of the people and their leaders. As the source of food for all people, rural and urban, it must have the regular, intelligent consideration that such indispensable wealth merits.

(4) That, since society as a whole depends absolutely on the produce of the land for its present and future existence, society as a whole must share in the responsibility and cost of maintaining land in a productive state. The individual land-

owner or operator has neither the resources nor the ability to carry the burden alone, and he has control only for a lifetime.

(5) That science must inevitably devote an increasing share of its attention to the problems of maintaining the substance and improving the yield of productive land.

(6) That action is imperative. Time is running out between the impending pincers of an increasing population and a dwindling area of productive land.

(7) That the technological key to future consideration of land development is scientific analysis of each parcel of land of any important extent to determine: (a) the type of production for which it is best suited physically and economically, as between row crops, forage, trees, grain, or wildlife; and (b) the conservation measures, such as terracing, strip cropping, and contouring, necessary to maintain it in a permanently productive state under maximum use.

(8) That practical treatment must be based on this analysis—the character of the land and its needs.

Lands vary widely from place to place and even on parts of the same farm or field. Every variation in the combination of soil, slope, climate, and susceptibility to erosion means a variation in the use and treatment necessary to keep the land permanently productive. Thus, engineering measures are used to supplement agronomic and fertility measures wherever necessary, and vice versa, according to need, adaptability, and economic limitations.

This is the basic principle underlying the new land technology developed in the United States during the past 14 years by the Soil Conservation Service (first called Soil Erosion Service). It is being applied to an ever-increasing area of land by American farmers, acting with the assistance of Service technicians. By the middle of 1947 more than 100,000,000 acres in all parts of the United States will be farmed in this modern conservation way; that is, each of the 100,000,000 acres or more will be used according to its individual capabilities and will be treated according to its conservation needs.

In the United States, land technology is spreading through a new democratic device known as the soil conservation district. The district is a subdivision of State government, brought into being by a process of referendum among the landowners and operators involved. In practical application it is a legal organization of landowners and operators within a designated area for the purpose of developing and carrying forward a mutually desirable program of soil and water conservation. Its principal advantages are in the encouragement of local initiative and in the greater strength that comes with organized numbers—farmers and ranchers working together.

In soil conservation districts the farmers themselves decide what they want to do to improve their land and water resources and how they want to go about doing it. Then they proceed along this course, working together, and utilizing all the available facilities and services they can command. In almost every instance, districts are obtaining technical guidance from the Soil Conservation Service.

On August 15 there were more than 1,670 districts in the United States, voluntarily voted into existence by the farmers themselves. These districts encompassed more than 900,000,000 acres and approximately 4,000,000 farms. Farmers are continuing to organize districts at the rate of approximately 25 per month.

Although democratic soil conservation districts are being employed in the United States to further the application of land technology, other nations may choose to utilize other means. A number, however, including the Union of South Africa, Mexico, and parts of Australia, have adopted the soil conservation district method.

In the long run, the overwhelming urge of mankind for survival will dictate that every remaining productive acre be handled in such a way that it will continue to produce indefinitely. In the meantime, other factors are combining to speed up the application of technology to the land. From the standpoint of the individual and the nation alike, the development and application of soil and water conservation technology (the tool of soil conservation science) is good business. It results in greater yields and greater returns per acre for the capital and labor expended. Moreover, it maintains or improves the basic strength and self-sufficiency of individual and nation. It probably can prevent at least half the potential famines of the future.

By increasing the per-acre, per-farm, and per-nation supply of food and fiber, conservation technology can provide the basis for an improved standard of living and simultaneously reduce the hunger and discontent among peoples which so frequently leads to discord, dictatorships, and war.

For these and other reasons, the application of land technology is certain to spread around the world, either voluntarily or by decree. By the year 1996 this world journey probably will be well advanced. By that year or before, it will have accomplished changes in agriculture tantamount to a beneficial revolution on the land.

Almost certainly, productive land will have become a major factor in national and international deliberations. In all probability there would have been better international relationships if we had worked together more on ways and means of keeping land productive.

Production in the agricultural areas of the world will be more diversified; there will be pronounced increases in the acreages devoted to livestock and trees.

Agricultural production will be restored or improved in millions of communities throughout the world, solving in large measure some of the most difficult problems of food distribution and human nutrition now confronting mankind.

The nutritive value of food produced on land rich in the constituents of plant nutrition undoubtedly will be greater than that from impoverished land, which has been stripped of its topsoil by erosion, with everything the topsoil contains: available elements of nutrition, both minor and major, all that man puts into the topsoil, and everything else. With so much eroded land around the earth, is there any wonder that malnutrition and famine are so widespread?

Development of land and water resources for agriculture, as by drainage or irrigation, will be governed primarily by factual, technological elements of land use and land maintenance rather than by promotional, exploitive, or political standards.

Also, people will learn that it is easier on machine, horse, and man to farm according to conservation standards than to follow haphazard methods not fitted to the land. Less fuel and time, for example, are required to operate a machine on the level, on the contour, than up and down slopes, and there is less wear on the machine.

The heavy costs of erosion, now running to approximately $3,844,000,000 a year in the United States alone, will be sharply cut.

Farming will become an expert profession; the inexpert and inept will be forced off the land. It is not impossible that the prospective farmer of the future will be required to satisfy society that he is qualified by training and experience to take on the trusteeship of a piece of productive land.

Most important, man will have learned the true value of his most precious natural resource. Tragically, throughout history, the land has been the most neglected.

On this job of safeguarding the land, thousands of farmers, in addition to various local, state, and federal agencies, are vigorously pushing ahead with the work. Each individual so engaged is a part of the biggest job, I think, in engineering and human affairs ever undertaken anywhere.

Do Certain Drinking Waters Favor Dental Caries?

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IT IS NOW GENERALLY RECOGNIZED that children who consume drinking waters containing from 1 to 2 ppm of fluoride (F) during the first decade of life have a lower experience with dental caries than do comparable children consuming nonfluoride waters.[1] It is the purpose of the present note to describe findings which suggest that drinking waters may contain deleterious factors which *favor* attack by dental decay.

During the winter and spring of 1946, with the cooperation of Dr. J. M. Wisan, chief of the Division of Dental Health, New Jersey Department of Health, and with the assistance of Dr. John F. Cody, senior assistant dental surgeon, U. S. Public Health Service, a total of more than 3,000 school children were examined in five communities of southern New Jersey. In three of these communities the water supplies contain from 1.4 to 2.2 ppm of fluorine, while the remaining two communities have water supplies which are considered fluorine-free. (The water analyses were made by Dr. Elias Elvove, senior chemist, U. S. Public Health Service.)

Of the approximately 3,000 children, 1,307 were born in localities outside the five communities studied, but had migrated at various ages into the several communities where the examinations were made. Those migrating into the fluorine communities and consuming the fluorine waters continuously since first arrival totaled 882, while those migrating into the nonfluorine communities and consuming the nonfluoride waters continuously totaled 425. What effect do these two types of drinking water have on the caries attack rate of the migrants?

TABLE 1

Number of Decayed, Missing, and Filled (DMF) Teeth per 100 Person-Years of Age for Migrants Into Fluoride and Nonfluoride Areas of New Jersey*

Age (years) at time of survey	Area in New Jersey	Duration of exposure (years)		
		0–4	5–9	10–14
5–9	Fluoride	8.6	5.5	†
	Nonfluoride	19.3	20.3	†
10–14	Fluoride	36.7	22.2	15.5
	Nonfluoride	37.6	44.3	57.5
15–19	Fluoride	56.6	43.5	33.3
	Nonfluoride	49.6	61.1	70.0

* Data based on observation of 1,307 migrants of both sexes of specified ages and of specified duration of continuous exposure to the city water in the specified areas.

† No observations.

The caries attack rate for the present study is defined as the number of teeth of the permanent (second) dentition showing evidence of past or present attack by dental caries (decayed, missing, or filled) per 100 person-years of age. The findings are given in Table 1 and Fig. 1.

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[1] "Fluorine in Dental Public Health": Symposium-Conference of the New York Institute of Clinical Oral Pathology, October 30, 1944, New York City.

The data clearly show that the sooner after birth a child arrives in the fluoride area and begins a continuous exposure to fluoride water, the lower the caries attack rate. From these findings the conclusion is reached that, for migrants, drinking of fluoride waters is associated with lower dental caries attack rates. At the same age, migrants protected most are the earliest to arrive (longest exposed); those protected least are the most recent arrivals (shortest exposed).

In contrast, migrants into the nonfluoride area present a strikingly different picture. Among such migrants, those who are the most recent arrivals have the best teeth (lowest attack rate), while those who have been in the nonfluoride area the longest time have the worst teeth (highest attack rate).

These several findings strongly suggest that, just as there are factors in drinking water which favor *resistance* to tooth decay, there may be factors in drinking water which make the teeth *more vulnerable* to dental caries. Search for the principles in the nonfluoride waters responsible for the described effects is now actively under way. Superficial examination indicates that the nonfluoride waters in this area are acid enough to require treatment with alkali, and they contain excess iron to such an extent that aeration is required to remove it. Preliminary chemical analysis indicates an unusually high content of nitrates, constituting more than one-half of the fixed residue.

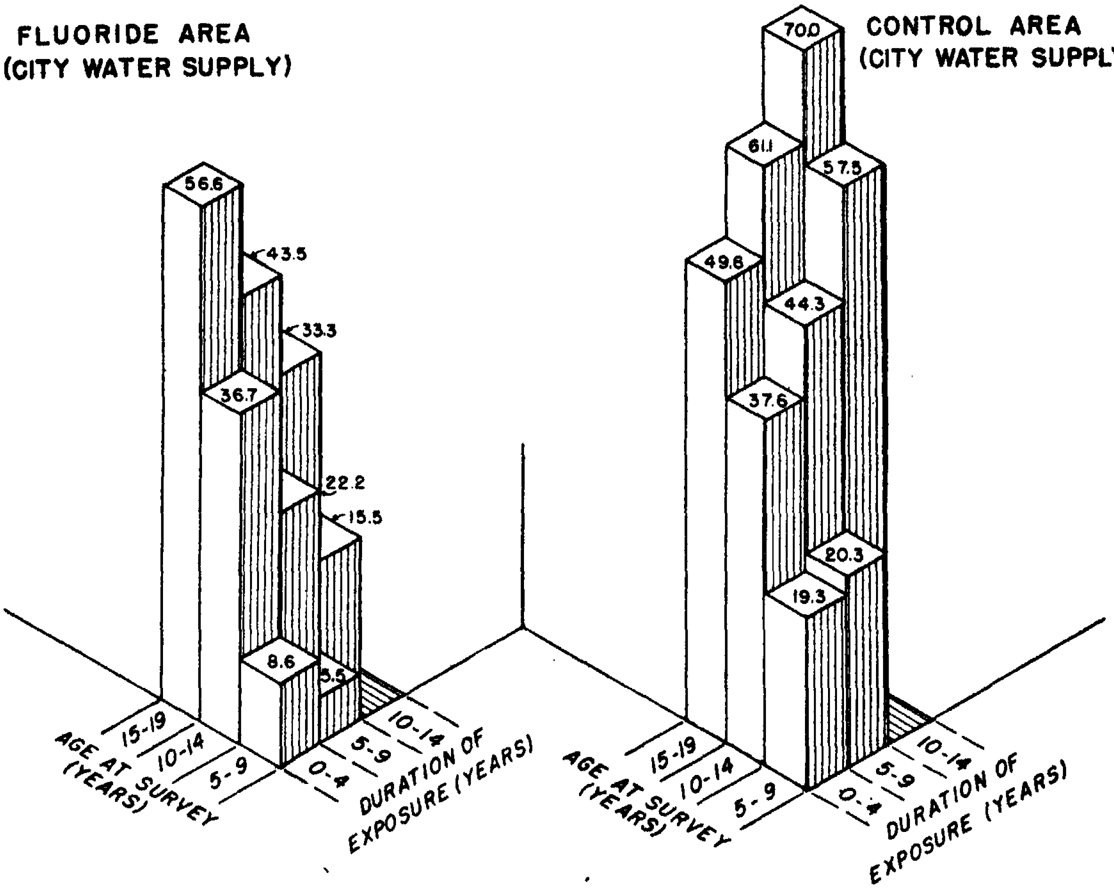

FIG. 1. Relationship between duration of exposure to fluoride or nonfluoride drinking water and number of decayed, missing, and filled (DMF) permanent teeth per 100 person-years of age in migrants of specified ages. (Numbers on tops of columns equal number of DMF permanent teeth per 100 person-years of age.)

Scanning Science —

It is reported by cablegram that Alfred Nobel, the engineer and chemist, who died at San Remo, Italy, on December 9th [*sic*], left a will bequeathing his entire fortune, amounting to about $10,000,000, to the Stockholm University.

—January 1, 1897

NEWS *and Notes*

President Conant called on science writers to help in interpreting to the general public both the "need for a National Science Foundation and the basic conditions for its proper functioning" in his presentation of the 1946 AAAS-George Westinghouse Science Writers' Award to James G. Chesnutt, of the San Francisco Call-Bulletin, on Friday, December 27. The program was broadcast from the Statler Hotel, Boston, through WBZ and associated stations.

In speaking to some 150 press representatives who attended the award luncheon, President Conant pointed out that during the war, colleges, universities, and research institutions had come into closer contact than ever before with the Federal government through OSRD. "No one can deny," he said, "the importance of the work done by colleges and universities for the Federal government during the war years."

"Today, fifteen months after V-J Day we still find the colleges and universities having many dealings with the Federal government. Thanks to the so-called G.I. Bill, large numbers of veterans are receiving college and university education with substantial subsidies from the Federal government. We are in effect operating our colleges with a Federal scholarship program for those who served in the armed forces of the country. But that is another story.

On the research side many institutions are operating research contracts with the Army and the Navy though on a non-secret basis. The leaders of the armed forces have been farsighted in supporting such basic research, but this is presumably not the final answer to channeling Federal funds.

It is natural for those concerned with the future of advanced education to wonder what lies ahead after the period of demobilization is over. Is Federal money to continue to flow to our institutions of advanced learning? If so, how can we avoid the development of a centralized control of higher education which everyone admits would be most unfortunate. In looking into the future, it seems important for all of us to think as clearly as possible about the relation of our educational institutions to the Federal government. This is no simple problem, the answer to which can be summed up in a headline or a few *clichés*. Rather, it is one of those intricate problems in the organization of modern society that needs careful analysis and thoughtful consideration.

In a very challenging document published by the government more than a year ago, entitled *Science, The Endless Frontier*, there was set forth a strong argument for the establishment of a new Federal agency, the National Science Foundation. This agency was to be erected by Congress and supplied with funds for the purpose of supporting basic scientific research in the universities and colleges of the land. A bill embodying the essential features of this report passed the Senate at the last session, but time was too short to permit of its final consideration on the floor of the House.

I very much hope that this bill, or one very closely related to it, will be passed by the coming Congress. It seems to me that it is a matter of great importance to the country that this should be done.

With the record of the war behind us, one need hardly argue for the importance of basic scientific research as an integral part of a national defense program, and alas, in the type of world we now live it is necessary to consider the problems of national defense. Until such time comes when we can drastically reduce our Army and our Navy and our Air Force, until such time comes that we are living in a world where problems of national security are no longer of major importance, the government clearly must support the development of basic scientific research and the education of scientific workers if for no other reason than because of the importance of these activities in terms of the total military picture. There is, of course, another important reason, or rather two, for the Federal support of scientific research, namely, the fact that the development of modern industry on the one hand, and modern medicine on the other, are tied closely to the development of modern science.

When this National Science Foundation is created, as I hope it will be, it will be in a position to make grants of money to the universities for the support of the very expensive basic research in such sciences as physics, chemistry, biology, geology, psychology. Such grants would be in no way connected with direct military projects. Indeed, in time of peace I think it highly inadvisable for universities which are dedicated to free investigation to undertake the type of investigation they did during the war for patriotic reasons, namely, secret or confidential work. All secret research in days of peace should be done in government laboratories, arsenals, and proving grounds.

If the National Science Foundation is properly set up and properly managed, I have no fear myself that there will be any deleterious effects to the universities even if they receive very large sums of money for the support of scientific research by this route from the Federal government.

The event marked both the conclusion of the 1946 award year for the science writers and the opening of the AAAS Boston Meeting. In addition to the winner of the $1,000 cash award, honors also went to Stephen White of the *New York Herald Tribune* and Herbert Shaw of the *Dayton Daily News*, as announced previously in *Science*.

Among the guests at the luncheon were Admiral H. G. Bowen, Vice Admirals Parsons and P. F. Lee, Major General Curtis LeMay and Malcolm Grow and Charles F. Kettering, whose address as retiring president on the evening of the 27th was printed last week in *Science*.

The Council announced the election of Harlow Shapley as president for 1947 and E. W. Sinnott, president-elect. The new constitution provides that the president-elect shall take office as president in 1948. On January 15 President Conant, who presided at the Boston meeting, will become the chairman of the Executive Committee. From this time on the services of one man are continuous for three years as president-elect, president, and chairman of the Executive Committee.

Following the announcement of the election results for 1947, the Council passed a resolution calling for the formation of an Inter-society Committee for a National Science Foundation, appropriated funds for starting the organization, and instructed the appropriate AAAS officers to extend an invitation to other national educational and scientific societies to participate in the new effort to secure some action in the present Congress.

The resolution was prepared by a Council committee, Kirtley F. Mather, chairman, Harlow Shapley, Joseph Boyce, George A. Baitsell and Stuart Mudd, appointed on December 26. The resolution said in part: "For many years the Government has wisely supported research in the agricultural colleges and the benefits have been great. The time has come when such supports should be extended to other fields of science and to advanced scientific education. There is not now in the governmental structure any civilian agency, receiving its funds from the Congress, adapted to providing the necessary supplementation of funds or the necessary additional support of basic research in medicine, national defense research or basic sciences, or adapted to administering a program for the support of advanced scientific education."

About People

John J. Brown has been appointed chief of the Design Branch, Plants Division, Technical Command, Edgewood Arsenal, Maryland. During the war Lt. Col. Brown was in the Chemical Corps and was transferred to the Corps of Engineers for work on the India-China pipe line.

Aaron F. Bracken, professor of agronomy at the Utah State Agricultural College, left on December 1 to assume his duties as agricultural adviser to the Syrian Government.

Frederick F. Yonkman, director of research at Ciba Pharmaceutical Products, Inc., Summit, New Jersey, addressed the Medical Association of Puerto Rico during its annual meeting, held December 11–15. His topic was "Antihistaminic Agents: A New Approach to the Treatment of Allergy."

S. Francis Howard has retired as head of the Chemistry Department, Norwich University, Northfield, Vermont, following 50 years of teaching, 33 of which were spent at the University. P. D. Baker has been appointed his successor.

Wendell M. Stanley, of the Rockefeller Institute for Medical Research, who was named as a 1946 Nobel Prize winner in chemistry (see *Science*, 1946, 104, 483) is writing a book on virus diseases, to be published soon by Princeton University Press.

J. A. Southern, of Furman University, has been elected secretary-treasurer of the South Carolina Academy of Science.

George M. Maxwell has been appointed assistant professor of biology at the Jersey City Junior College, New Jersey. Previous to this appointment he was head of the Department of Biology and acting head of the Chemistry Department at St. Peter's College, professor of histology and embryology at Fordham University, and head of the Department of Biology at Marymount College.

Freeman S. Howlett, professor of horticulture, and member of the Ohio State University staff since 1929, has been named acting chairman of the Department of Horticulture and Forestry, following the recent death of Joseph H. Gourley.

J. B. Austin has been named director of the Research Laboratory of the United States Steel Corporation of Delaware, succeeding John Johnston, who has retired. Dr. Austin, formerly assistant director, has been associated with Dr. Johnston at the laboratory since its inception in 1928.

Robert De Vore Boche has been appointed assistant professor jointly in the Department of Zoology and in the Institute of Radiobiology and Biophysics, University of Chicago.

Ross C. MacCardle recently resigned his position as assistant professor of anatomy at Washington University, St. Louis, to accept appointment as cytologist in the National Cancer Institute, Bethesda, Maryland.

Kenneth B. Disher was appointed director of the Cleveland Museum of Natural History, effective October 16. He was formerly executive secretary of the Allegheny State Park Commission, New York, and previously had been associated with the Department of the Interior.

Katherine H. Heinig, instructor in botany at Wells College from 1937 to 1945, is now at Connecticut College, New London, as an assistant professor in the Department of Botany. Miss Heinig did graduate work at Cornell University in 1945–46, completing the work for her doctorate during the past summer.

Charles Mayo Goss has been appointed professor and head of the Department of Anatomy at the School of Medicine, Louisiana State University, and will join the faculty on February 1, 1947. He has been head of the Department of Anatomy at the University of Alabama since 1938.

Charles M. Riley has been made Longyear Fellow in Metalliferous Economic Geology at the University of Minnesota. The Longyear Fellowship was established by the E. J. Longyear Company, Minneapolis, in the spring of 1946 for basic research on the problems of finding hidden ore bodies by geological, geophysical, and other means. His work will be under the direct advisership of Frank F. Grout.

Walter Ramberg has been named chief of the Engineering Mechanics Section of the National Bureau of Standards, according to E. U. Condon, director. Dr. Ramberg, who has directed the Bureau's aeronautical research program since 1937, succeeds H. L. Whittemore, who recently retired after 29 years service at the Bureau.

Harold A. Abramson, assistant professor of physiology, Columbia University, was recently awarded the Legion of Merit for research activities as a medical officer assigned to the Chemical Warfare Service. In the description of services performed, emphasis is placed upon the fact that in 1942 Dr. Abramson initiated the project on, and subsequently directed the research pertaining to, penicillin aerosol therapy of the lungs.

W. Ewart Williams was named as a consulting physicist on Bausch & Lomb Optical Company's research and engineering staff on November 26. A resident of Pasadena, California, since 1939, Dr. Williams is an authority on interferometry, the phase of physics dealing with the measurement of wave lengths of light. Prior to coming to the United

States, he taught physics and optics at King's College, University of London, for 17 years, and also served as research physicist for Adam Hilger, Ltd., manufacturers of scientific optical equipment.

Gordon Gunter, on leave of absence from the Institute of Marine Science, University of Texas, is currently visiting professor in the Department of Zoology and research associate in the Marine Laboratory, University of Miami, Florida.

Edwin P. Hiatt, School of Medicine, University of North Carolina, has received a grant from the Cinchona Products Institute for continuation of his work on the effects of quinine and other cinchona alkaloids on renal function and blood pressure.

Harold C. Urey, traveling abroad at present, delivered the Liversidge Lecture for the Chemical Society in London December 18 and repeated the lecture in Edinburgh December 19. On December 14 Dr. Urey received the honorary degree of D.Sc. from Oxford University.

C. Jayaratnam Eliezer, 26, research fellow at Cambridge University, England, won the $2,000 Mayer Award for an essay on the nature of light, "The Interaction of Particles and an Electromagnetic Field." The prize was administered by the National Science Fund, National Academy of Sciences, of which Harlow Shapley is chairman. Dr. Eliezer, a native of Ceylon, taught at the University of Ceylon from 1943–1946. While at Christ College, Cambridge, he won the Smith Prize in mathematics.

Donald W. Kerst, University of Illinois, received the John Scott Award on December 19 for his invention of the betatron. The $1,000 prize was presented to Dr. Kerst in Philadelphia, where on November 16 he received for the same invention the Cyrus B. Comstock Prize of the National Academy of Sciences. Dr. Kerst's first betatron went into operation at the University of Illinois July 15, 1940. The John Scott Medal Fund derives from a gift of John Scott, chemist, St. Patrick's Square, Edinburgh, Scotlant, to the city of Philadelphia in 1816. The original bequest was $4,000, a sum which had grown to $100,000 by 1917 when court action was taken to increase the amount of annual awards from the original value of $20.

Ernest M. Stoddard, for 57 years plant pathologist at the Connecticut Agricultural Experiment Station, has been awarded the 1946 Certificate of Distinction given annually by the Connecticut Pomological Society for outstanding achievement in the field of pomology. The award was presented at the annual dinner of the Pomological Society in Hartford on December 10, when the presentation address was given by Sherman P. Hollister, professor emeritus of horticulture at the University of Connecticut.

Lauriston S. Taylor, chief of the X-Ray Section, National Bureau of Standards, has been awarded the Medal of Freedom for work on improved methods of bombing and bombing accuracy in the European theater, the Bureau of Standards has announced. At the same time Mr. Raylor received the Bronze Star Medal for "outstanding leadership, analytical ability, and technical skill in prosecution of the war." As chief of the Operational Research Section of the Ninth Air Force, Mr. Taylor headed a civilian group of scientists in work on bombing accuracy, selection of bombs and fuses, radar, radar countermeasures, selection methods for lead crews, and blind bombing.

Mr. Taylor joined the Bureau in 1927 and became chief of the X-Ray Section in 1941. Prior to service in Europe he was active in development of the radio proximity fuse. ◆

Four biologists have been elected to the Academy of Sciences of the USSR, according to Science Service. The new members of the Academy are Boris Isachenko, Konstantin Bykov, Alexander Oparin, and Nikolai Maximov. Boris Isachenko, a microbiologist, is an arctic explorer and student of bacteria of the Arctic Ocean. He has published works on mycology and the role of microorganisms and self-heating of grain and peat. A student of Ivan Pavlov, Konstantin Bykov has extended Pavlov's teachings on the higher nervous system. Prof. Oparin is the author of a new theory of the origin of life and has done research in plant biochemistry and fermentology. Prof. Maximov, director of the Institute of Physiology of Plants of the Academy and head of the Timiryazev Agricultural Academy, has studied the resistance of plants to drouth and frost.

Robert B. Kleinhans, formerly head of the Department of Biology, Athens College, Athens, Greece, who served as a lieutenant commander at the U. S. Naval Academy and with the Allied Mission for Observing the Greek Elections, is now assistant professor in biology and director of the Beal-Maltbie and Thomas R. Baker Museums, Rollins College, Winter Park, Florida.

William Parks Yant has been chosen as the 1946 recipient of the Pittsburgh Award, bestowed annually by the Pittsburgh Section of the American Chemical Society for outstanding service to chemistry. Dr. Yant, director of research of the Mine Safety Appliances Company, has "contributed prolifically to Pittsburgh's science, industry and welfare," according to Dean Herbert E. Longenecker of the Graduate School of the University of Pittsburgh, chairman of the Section.

John V. Scudi has been appointed director of research at the Pyridium Corporation, Nepera Park, New York. Dr. Scudi was formerly head of the Biochemical Research Laboratories at Merck & Company, Inc., and more recently was assistant professor of pharmacology at the College of Physicians and Surgeons, Columbia University. Edmund T. Tisza, who has been director of research for the past 20 years, will continue in active service as technical adviser to president.

Mary Louise Forgach has joined the research staff of the Smith, Kline, & French Laboratories, Philadelphia.

Graham DuShane, formerly of University of Chicago, has been appointed professor of biology, Stanford University.

W. Taylor Sumerford, formerly of the University of Georgia, has been added to the faculty of the Chemistry Department, Louisiana State University, with the rank of associate professor.

E. Newton Harvey, Princeton University, gave a series of seminars and lectures during the week of December 2 at Ohio State University, under the auspices of The Graduate School and the Society of the Sigma Xi.

Sir Robert Robinson has accepted the invitation of the Council of the Chemical Society to deliver the Faraday Lecture during the Society's Centenary Celebrations in July 1947. The Faraday Lectureship was founded in 1867 to commemorate Michael Faraday, who was elected a fellow of the Society in 1842 and was one of its vice-presidents.

Awards

Tom Fite Paine, Jr., Aberdeen, Mississippi, **has been awarded a research fellowship for the year beginning July 1, 1947 under the sponsorship of the American College of Physicians.** The fellowship provides for the continuation during this period of the study of infectious diseases, with particular regard to chemotherapy and the use of antibiotics, in which Dr. Paine is currently engaged at the Thorndike Memorial Laboratory, Boston City Hospital, under the supervision of Maxwell Finland.

The Mayo Foundation for Medical Education and Research was awarded the annual citation of the American Pharmaceutical Manufacturers' Association at a program in New York City on December 9. The citation read: "In recognition of its great contributions to public health, by fundamental research in the field of the medical sciences, for the profound and lasting benefit of mankind."

Last year the award went to the Rockefeller Institute for Medical Research, for broad research in the field of the medical sciences.

This year Isaiah Bowman, president of Johns Hopkins University, made the presentation address, on "Contributions of Chemistry and Physics to Medicine," while Donald C. Balfour, director of the Mayo Foundation for Medical Education and Research, gave an acceptance address on "Eras in Medical History."

Industrial Labs

Compulsory retirement on a calendar age basis should be abandoned, Theodore G. Klumpp, president of the Winthrop Chemical Company, New York, told the American Public Health Association at its annual meeting on November 14. Noting that the adult population was steadily increasing in proportion to the total population, Dr. Klumpp predicted that by 1980 "there will be not less than 60,000,000 Americans 45 years and over and more than 21,000,000 who are 65 and over."

Recognizing the social problems implied in the increase in the adult population, Dr. Klumpp offered this 7-point program:

(1) Since physiological age is not synonymous with chronological age, compulsory retirement on a calendar age basis should be abandoned.

(2) Since hiring is selective and based on fitness to do a given job, retirement should likewise be selective and based on unfitness.

(3) Compulsory retirement should be based on the recommendation of a retirement board composed of medical and psychiatric members as well as administrative officials.

(4) If wage in proportion to performance is recognized as a fundamental principle, the older worker should taper off in industry, just as the young apprentice gradually works himself up in skill, performance, and remuneration. In other words, opportunities for downgrading in position and salary should be offered.

(5) Industry, and governmental and private institutions, must make a greater and more intelligent effort to employ partially disabled persons.

(6) When the aged and disabled have work to do, they are less of a burden, financially, socially, and spiritually, to those at home. Other things being equal, home environment is better than an institution for the aged and disabled.

(7) Institutions for the aged and disabled must be changed from asylums to modern institutions where every convenience and scientific development is available for their physical, mental, and spiritual comfort.

"Society," Dr. Klumpp said, "has been quite illogical and inconsistent in its attitude toward the older worker. On the one hand, we have no objection to electing and appointing older individuals to positions of the greatest responsibility in government, business, and the professions. And yet, as far as the rank and file of workers is concerned, we impose blind and unselected compulsory retirement rules which automatically eliminate those in the ranks who have reached a certain age regardless of their fitness, ability, and contribution to the group for which they labor."

The Miles Laboratories, Elkhart, Indiana, has made a grant-in-aid of $7,075 for blood grouping studies and research on antibiotics in Utah plants, under the direction of G. A. Matson, associate professor, Department of Bacteriology, University of Utah School of Medicine.

The Council on Industrial Health, American Medical Association, Chicago, has appointed Ernest W. Brown (MC), U.S.N., recently retired, executive officer for the Council's Committee on Scientific Development. He will be concerned mainly with industrial medical education and industrial toxicology. During the war Captain Brown was attached to the Office of the Surgeon General of the Navy in charge of industrial hygiene research, submarine medicine and chemical warfare medicine. He also served as liaison officer to the committees on industrial medicine and armored vehicles of the NRC.

Universities

Two new professorships in the Practice of Engineering, substantially analogous to clinical professorships in medical schools, giving recognition to the services of engineering practitioners, have been established by Harvard University in its Graduate School of Engineering.

Karl Terzaghi and Howard M. Turner are the first holders of these professorships in civil engineering. Prof. Terzaghi has been with the Graduate School of Engineering as lecturer on soil mechanics and engineering geology since 1938; Prof. Turner has been lecturer on water power engineering since 1919.

The University of Wisconsin recently purchased for $300,000 the extensive scientific library of the late Chester H. Thordarson, electrical manufacturer and inventor. The library contains 11,000 volumes, 60 per cent of which are scientific.

West Virginia University College of Agriculture, Division of Forestry and Home Economics, has recently acquired a new building for the use of the Forestry Division and the Department of Agricultural Engineering, enabling expansion of both the work and facilities of these units.

The 75th anniversary of the Missouri School of Mines and Metallurgy was commemorated recently in Rolla, Missouri, by an academic convocation at which Frederick A. Middlebush, president of the University of Missouri, presided. Eugene McAuliffe, chairman of the Board of Trustees, Union Pacific Coal Company, delivered the principal address on "The Engineer's Contribution to Society and the World." Honorary degrees in engineering were conferred upon James Presley Gill, vice-president of the Vanadium Alloys Steel Company, and Herbert Russell Hanley, professor emeritus of Metallurgical Engineering at the Missouri

School of Mines and Metallurgy. Established in 1871 and maintained jointly by the State of Missouri and the Federal Government under the provisions of the Morrill Act of 1862, the School has provided technical and scientific education to more than 10,000 students, with instruction in seven major departments.

New York University has announced, through Chancellor Harry Woodburn Chase, a special emergency supplementary payment of $400 to all full-time members of the teaching and administrative staffs of the institution, under Council appointment, in active service since September 1, 1946, and still serving at the time the payment will be made, January 1, 1947. Supplementary emergency compensation of varying amounts, based on length of service, has also been voted to members of the clerical, laboratory, and plant staffs in continuous employment from September 1, 1945, to the time of payment. It was estimated that the special disbursement would cost the University between $500,000 and $600,000.

Meetings

The American Association of Junior Colleges will hold its 27th annual meeting February 19–22 at the Hotel Jefferson, St. Louis.

The Antibiotics Study Section of the National Institute of Health will meet in Washington, D. C., on January 31 and February 1 together with commercial producers of antibiotics and others interested in antibiotic research. All interested investigators are invited to attend. Inquiries about the meeting and presentation of reports should be addressed to Gordon Seger, Dr. P. H., Antibiotics Study Section, National Institute of Health, Bethesda 14, Maryland.

The Chemical Corps Technical Command held a conference on turbulent diffusion on November 16 at Edgewood Arsenal, Maryland. Among those taking part was a panel of consultants including P. A. Leighton, dean of the School of Physical Sciences, Stanford University; A. H. Corwin, head of the Chemistry Department, Johns Hopkins University; and H. F. Johnstone, head of the Chemical Engineering Department, University of Illinois.

The Association of Medical Illustrators, which was organized in Chicago in July 1945, held its first annual convention in Philadelphia the week of September 23, 1946. The stated purpose of the organization is "to promote the study and encourage the advancement of medical illustration and allied fields of visual education; to advance medical education; and to promote understanding and cooperation with the medical and related professions."

The American Mathematical Society held its 419th meeting at Princeton University on November 2, in connection with the year-long celebration of Princeton's bicentennial. The attendance was approximately 250, including 217 members of the Society. Forty-nine research papers were presented, 18 in person and 31 by title. By invitation, an address entitled "Combinatorial Homotopy Theory" was given by J. H. C. Whitehead, Waynflete professor of pure mathematics at the University of Oxford. In the evening, under the auspices of Princeton University, an informal discussion of the current state of mathematics throughout the world was held. Einar Hille presided, and brief talks were given by Harald Cramér, Claude Chevalley, Solomon Lefschetz, H. P. Robertson, and Marston Morse.

The National Malaria Society, at its 29th annual meeting at Miami, Florida, on 4–7 November, adopted a new constitution and by-laws and elected the following officers: president, Mark D. Hollis; president-elect, E. Harold Hinman; vice-president, Wendell Gingrich; secretary-treasurer, Martin D. Young; and board of directors, Justin M. Andrews (one year), L. W. Clarkson (two years), and W. H. W. Komp (three years).

The Tennessee Academy of Science, at its annual meeting on November 30, elected the following officers for the coming year: president, Paris B. Stockdale, head of the Department of Geology and Geography, University of Tennessee; vice-president, W. M. Deacon, head of the Department of Biology, Vanderbilt University; secretary-treasurer, James G. Walls, assistant professor of geology, University of Tennessee; AAAS councillor, Clinton L. Baker, head of the Department of Biology, Southwestern University; and editor, Jesse M. Shaver, head of the Department of Biology, George Peabody College for Teachers.

The Academy of Natural Sciences of Philadelphia has published Volume I, Part 2, of Land Mollusca of North America (North of Mexico), by Henry A. Pilsbry. This two-part monograph will be completed with the publication of Volume II of Part 2 in 1947. The first volume of Part I appeared in 1939 and the second in 1940. Completion of the work was delayed by the war. Dr. Pilsbry, 84 on December 8, has been a member of the Academy's scientific staff for 60 years. He is still an active field collector and has recently been on an expedition to Guatemala, traveling by air.

The American Academy of Tropical Medicine held its 13th annual meeting at Hotel Alcazar, Miami, Florida, on November 6, in conjunction with the Southern Medical Association and in association with the American Society of Tropical Medicine. Lowell T. Coggeshall, University of Chicago, presided, and Brig. Gen. James S. Simmons, dean of the School of Public Health, Harvard University, delivered the annual presidential address on the subject, "Tropical Medicine and the Challenge of Global Peace." At the annual business session of the Academy the following persons were elected to membership: Col. Karl R. Lundeberg (MC), USA, Washington, D.C.; Oliver R. McCoy, Rockefeller Foundation, Paris, France; Gilbert F. Otto, Baltimore, Maryland; and Capt. James J. Sapero (MC), USN. Officers elected for 1947 were: president, George K. Strode, Rockefeller Foundation, New York City; vice-president, George C. Shattuck, Harvard Medical School; secretary, Ernest Carroll Faust, Tulane University; treasurer, Jean A. Curran, Long Island Medical College; and councillor for a five-year term, Justin Andrews, Communicable Disease Center, U. S. Public Health Service, Atlanta, Georgia.

The 1947 Broadcast Engineering Conference sponsored by the departments of engineering at the University of Illinois and Ohio State University has been cancelled due to crowded conditions and lack of personnel. The 1947 conference was to have been held at the University of Illinois.

The American Society of Photogrammetry, a group of aerial photographic, mapping and charting experts, will hold its winter meeting January 22–24 in Washington, D. C., at the Wardman Park Hotel. Gerald Fitz Gerald, U. S. Geological Survey, president of the society for 1946, will be succeeded by Revere G. Sanders of the Fairchild Camera and Instrument Corporation.

A fellowship for graduate study in geology has been established at Yale University by the Stanolind Oil and Gas Company. The fellowship is open to students whose interest is either in general geology or in any branch of the subject that has logical application to the petroleum industry. A student appointed to the fellowship will have no obligation in his choice of employment following graduation. For the year 1946–47 the fellowship has been awarded to James Lee Wilson, who received his Master's degree from the University of Texas in 1944.

The Department of Botany, Wellesley College, announces that Harriet B. Creighton, lieutenant in the Navy for the past three years, has returned and been made chairman of the Department. Other recent additions to the staff are Lora Bond, formerly of Drury College, Springfield, Missouri, and the University of Wisconsin, and Helena A. Miller, formerly of Connecticut College, New London, and Harvard University.

CARE packages totaling more than one and a third tons have been sent by ornithologists in Canada and the United States to their European colleagues in the past few weeks. Attention of scientists in Canada and the United States has been called to the needs of many colleagues abroad who still face starvation conditions, and the suggestion made that scientific societies purchase food packages available through The Cooperative for American Remittances to Europe. CARE is a non-profit organization through which individuals and organizations may order standard food packages at $10 for delivery in Austria, Belgium, Czechoslovakia, Finland, France, Greece, Italy, The Netherlands, Norway, Poland, the American, British and French zones of Germany, and all of Berlin. Standard food packages, obtained by CARE through the War Assets Administration, are called the "10-in-1" because they were originally designed by the U. S. Army to feed soldiers in groups of ten. An average of over 40,000 calories of balanced foods are included, which will feed a family of four a 2800 calory meal each day for two weeks. Further information and order blanks may be obtained from CARE, 50 Broad St., New York 4, N. Y.

The National Research Council of Canada recently listed the activities of its newly formed Committee on Dental Research, organized to stimulate and coordinate dental research in Canada. Projects now under way are: investigation of chemical mechanisms involved in decrease of dental caries by fluorides; chemical studies of nitrous oxide for dental anesthesia; investigation of packing materials in treatment of periodontal disease; improvement of certain properties of the acrylic resin denture base; study of effects of altitude, acceleration, and deceleration on oral tissues; investigation of effects of certain chemicals on materials in appliances used in prosthetic dentistry.

A reconnaissance party representing the National Geographic Society and the U. S. Army Air Forces has selected Bocayuva, State of Minas Geraes, Brazil (17° 15′ South Latitude, 43° 42′ West Longitude), as a site for the observation by a party of American scientists of the total eclipse of the sun on 20 May 1947. The point chosen is on a plateau at an elevation of 2,300 feet, about 400 miles north of Rio de Janairo. The expedition will be a joint undertaking of the two organizations named, in cooperation with the National Bureau of Standards, Georgetown Observatory, Naval Research Laboratory, and Yerkes and Lick Observatories. Fifteen scientists, under the leadership of Lyman J. Briggs, chairman of the Research Committee of the National Geographic Society, will be stationed at the base.

The totality of the eclipse will begin at Bocayuva at about 9:55 A.M. and will last for approximately 3 minutes, 50 seconds. At that time the altitude of the sun will be close to 40°. According to the program that has been worked out, the observers will seek to obtain photographs of the corona in black and white and in color, photographs showing the polarization of coronal light, and spectrograms of the flash spectrum and of the corona. Measurements will be made of the variation in brightness of the crescent of the sun as totality is approached, the changes which take place in the ionized layers of the earth's atmosphere, the times at which the moon makes its four so-called "contacts" with the sun's disk, and the apparent displacement of the positions of the stars close to the sun in order to test the Einstein theory of relativity. Studies will be made of the temperature of the corona near the limb of the sun and of the distribution of daylight intensity at various altitudes during the period of the eclipse.

The AAF will transport the most important instruments to the base by air, furnish the all-important time signals needed in the work of the civilian scientists, and maintain observation planes at various altitudes during the eclipse. During the progress of the eclipse AAF meteorologists will send up balloon-lifted radio sondes to gather information in regard to temperature, pressure, and water-vapor content of the air.

Suggestions for improvement of the dissemination of scientific news by Ralph W. Gerard speaking on a panel discussion in Boston, "Science and the Public," included certification of newsmen, more science features than spot news, training in scientific journalism, greater public service from scientific societies, approval or condemnation by official scientific bodies, public reports on scientific matters by boards of scientific consultants for newspapers, radios, and movies, government support of research and subsidy of mass media by government agencies of communication.

"Science, communication media and the public are inextricably bound to each other; they must not merely interact but interact usefully; each must minister to the needs of the others," he said.

The Union International Contre le Cancer has been invited by the Board of Directors of the American Association of Cancer Research to cooperate in holding the Fourth International Cancer Research Congres in September 1947 in St. Louis. E. V. Cowdry, director of research in the Barnard Free Skin and Cancer Hospital and professor of anatomy at Washington University, was appointed president of the Congress, at the Director's meeting held in the Sterling Hall of Medicine, Yale University, on October 13. At a meeting of the Executive Committee of the Union International Contre le Cancer, held in Paris on November 13, this invitation was accepted and Dr. Cowdry's appointment confirmed. Organization of the Congress is well advanced and announcement of committees is expected soon.

C. G. G. J. van Steenis, senior botanist, Department of Economic Affairs, Buitenzorg, Java, arrived in the United States December 16 to discuss with American colleagues his plans for the *Flora Malesiana*, a new flora of the Malaysian Archipelago now being prepared on an international cooperative basis. He is accompanied by Mrs. van Steenis who is completing the first volume of the flora, an extensive historical introduction.

The Committee for Foreign Correspondence of the Federation of American Scientists recently distributed over 10,000 pamphlets to scientists in 60 different nations. The literature, intended to aid nations in understanding problems underlying international atomic energy control, as well as necessity for control, included full texts of United Nations Atomic Energy Commission reports, the State Department's "Report on International Control of Atomic Energy," the booklet, "One World or None," and others.

The Council for Scientific and Industrial Research has established liaison offices in London and Washington. The officer-in-charge of the Washington office is E. P. Phillips, former chief of the Division of Botany and Plant Pathology, Department of Agriculture, Pretoria, South Africa. Scientific research workers and industrial technicians wanting information about their fields in South Africa should write to Dr. Phillips, 1785 Massachusetts Avenue., N. W., Washington 6, D. C.

A geological wall map of North America has been published by The Geological Society of America and is available for distribution. The map, begun in 1940, was compiled by George W. Stose, of the U. S. Geological Survey, from the latest published maps available. The compilation was financed by the Geological Society of America, the American Philosophical Society, and the American Association of Petroleum Geologists, and had the cooperation of the U. S. Geological Survey, the Geological Surveys of Canada and Mexico, state and provincial surveys of the United States and Canada, and individual geologists.

On a scale of 1:5,000,000, the map is printed in two sheets which, when mounted, make a wall map 76 inches high by 55 inches wide. Selection of the map units, their classification and arrangement in the legend, and adoption of the color scheme are by Mr. Stose. The map is printed in 19 geologic colors, 90 units being represented by color patterns. Orders for the map at $3.50 a copy should be sent to The Geological Society of America, 419 West 117 Street, New York 27, Attention: Miss M. Osborne.

A group of 60 U. S. college and university students will go to Sweden within the next few weeks to attend courses at the University of Stockholm. While designed to meet the needs of veterans studying abroad under the G. I. Bill of Rights, the courses are open to other qualified candidates. The first semester's work will be in English and will provide intensive training in the Swedish language and Scandinavian institutions. During the second semester courses will be offered on scientific and technical developments in Sweden, the Swedish language, and social, economic, and political conditions.

The National Geological Survey of China, reports it has returned to its old address, 942 Chukiang Road, Nanking, after 10 years. In 1936, following the Japanese invasion, the Survey set up temporary headquarters at Pehpei, near Cunking. Most work continued without interruption, it was noted; most publications came out despite drawbacks and are ready for exchange with other institutions.

Recent Deaths

Albert Davis Mead, 77, emeritus professor of biology, Brown University, died December 8 in Pasadena, California. He had been a member of the university faculty since 1895 and vice-president from 1926–1936.

Edward Laurens Mark, 99, emeritus professor of anatomy, Harvard, died at his home in Cambridge December 16. Dr. Mark taught at Harvard for 45 years, retiring in 1921 as Hersey professor of anatomy, a post he had held since 1885. He was director of the Harvard Zoological Laboratories from 1900 to 1921 and the Bermuda Laboratory for Research from 1903 to 1931.

Clyde Henderson Campbell, food chemist, died December 12 in St. Petersburg, Florida, where he had been for some time because of ill health. Before his illness he was state chemist for the city of Pittsburgh and later maintained his own food testing laboratory.

Elmer Victor Hjort, professor of chemistry and dean of the College, University of Miami, Florida, died suddenly at the university December 9. Dr. Hjort went to the University of Miami from the University of Pittsburgh as professor of chemistry in 1936. He was recently named dean of the university campus at Richmond Naval Air Base.

NRC News

Subcommittees of the Committee on Radioactivity of the Division of Physical Sciences, the formation of which was reported in last week's issue, have been designated as Subcommittees on Heavy Ionizing Particles, Beta and Gamma Ray Measurements and Standards, Neutron Measurements and Standards, Nuclear Constants, Disintegration Schemes, Instruments and Techniques, Units, Shipment of Radioactive Substances, Radiochemistry, Radiobiology, Geophysical Radioactivity, Publications and Information, and Liaison with Manhattan Project. As previously announced, members of the parent Committee are acting as chairmen, or coordinators, of these various Subcommittees.

A typical tentative outline of the functions of one of the Subcommittees, that on Neutron Measurements and Standardards, is: (1) investigate various types of standard sources of neutrons and determine methods by which these may be calibrated with reference to the rate of emission of neutrons and the distribution of energies of the neutrons under various conditions of measurement; (2) compare various methods for measurement with neutrons with an analysis of relative advantages and accuracy; (3) supervise collaborative programs for improvement of methods of measurement neutrons and determining relative distribution of energies; (4) make recommendations for the preparation of standard sources of neutrons and for their intercomparison; and (5) issue formal reports through the Subcommittee on Publications and Information.

The work of the previous Committee on Radioactive Standards, which was organized in November 1938, was interrupted in 1941 by the wartime activities of its members. Prior to 1941, however, the Committee had made recommendations for both radium gamma ray standards and beta ray standards.

TECHNICAL PAPERS

Vaginal Absorption of Penicillin

John Rock, Robert H. Barker, and W. Benjamin Bacon
Harvard Medical School, The Boston Lying-in Hospital, and *The Free Hospital for Women, Brookline, Massachusetts*

Vaginal suppositories containing 100,000 units of penicillin in a base of cocoa butter[1] were used on 20 patients divided into three groups: (1) nonpregnant women complaining of profuse leucorrhea and/or pruritus, (2) pregnant women a few days or weeks before delivery, and (3) women recently post partum. Two hundred thousand units were inserted at one time, and at least three serum levels of penicillin[2] were determined at intervals ranging from ½ to 8 hours afterward.

Group 1. Nine nonpregnant patients with vaginitis or chronic cervicitis, with a profuse discharge and/or pruritus, were treated. All patients experienced relief following penicillin treatment. Two patients had *Trichomonas* infections. In one, the organisms were still found after treatment, but, as in the other, the symptoms were absent. At least three serum levels were determined on all patients: in 5 patients, after ½ hour levels ranged from .312 to 1.250 units of penicillin/cc. of serum with an average of .687 unit; in 9 patients, after 1 hour, from .039 to 1.250 units with an average of .655 unit; in 4 patients, at 3 hours, from 0 to .156 unit with an average of .068 units; in 7 patients, at 4 hours, from 0 to .312 unit with an average of .120 unit; in 4 patients, at 6 hours, from 0 to .156 unit with an average of .039 unit; and in 3 patients, levels at 8 hours showed no concentration. As the necessary concentration for streptococcus control is considered to be .039 and for staphylococcus, from .078 to .1 unit, the critical amount was present in these patients for an average of 6 hours. There was a slightly higher rate of absorption in the patients who were near the end of their menstrual cycles and in two menopausal patients. One exception was a patient whose cycles were usually of about 28 days, and who on the 12th day had the high concentrations of .625, 1.250, .625, .312, and .156 units at ½, 1, 2, 4, and 6 hours, respectively.

Group 2. Four patients who were awaiting delivery were tested for absorption at ½, 1, and 4 hours after treatment. Of the three patients who were within two weeks of term, two showed no absorption of penicillin, and the third showed levels of .156, .039, and .078 units at the above intervals. One woman who was 2⅔ months short of term showed an absorption similar to that of nonpregnant women.

Group 3. Seven patients who had recently delivered were tested for absorption after receiving 200,000 units of penicillin. Results were similar to, even slightly better than, those in the nonpregnant patients of Group 1. Four patients, 10 days post partum, had high concentrations in their blood: at ½ hour, levels ranged from .625 to 1.250 units with an average of .938 unit; at 1 hour, from .625 to 1.250 units with an average of .781 unit; and at 4 hours, from 0 to .156 unit with an average of .063 unit. One patient, 9 days post partum, had no concentration at ½ hour and only .019 unit at 1 and 4 hours. Two patients, respectively 14 and 35 days post partum, showed moderate levels ranging from .312 to .039 unit at ½ hour, .312 to .312 unit at 1 hour, and 0 to .039 unit at 4 hours.

Summary. Except during the last two months of pregnancy, penicillin is easily absorbed from cocoa butter suppositories in the vagina, ordinarily to give therapeutic blood levels for from 4 to 6 hours. Penicillin in the dosage used seems to have a good effect on vaginal infections. In nonpregnant women, during the ovulation phase, considered as including days 14 ± 2 in the ordinary menstrual cycle of about 28 days, absorption seemed to be somewhat diminished. Higher levels were found in patients who were near the end of their menstrual cycles and in two patients who were menopausal. Patients who were very near term absorbed little or no penicillin, whereas patients 10 days post partum showed excellent absorption.

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[1] Generously supplied by Schenley Laboratories, Inc.

[2] All serum levels were determined by courtesy of Dr. Chester S. Keefer in his laboratory at the Evans Memorial Hospital, Boston University Medical School, by Dr. Donald G. Anderson and Miss Marjorie Jewell, whose cooperation is gratefully acknowledged.

Tumors in Intrasplenic Ovarian Transplants in Castrated Mice[1]

Min Hsin Li and W. U. Gardner
Department of Anatomy, Yale University School of Medicine

Investigations concerning the influence of steroid gonadal hormones on carcinogenesis have revealed many significant relationships. On the other hand, much less is known of the action of pituitary hormones on the development of tumors, although such relationships have been studied by injections of different pituitary preparations and by observing the effects of hypophysectomy on tumor-bearing animals or animals given carcinogenic substances (*10*). Recently, Pfeiffer and Hooker (*9*) obtained small local overgrowths of testicular interstitial cells in mice of the A strain that were given daily injections of pregnant mare's serum for several months. These growths resembled early stages in the development of the interstitial cell tumors that have been induced in estrogen-treated mice of this strain. The difficulty of obtaining purified and standardized gonadotropic hormones, and the formation of antihormones, have impeded adequate study of the long-term effects of gonadotropins.

It has been shown that many estrogenic and androgenic hormones are inactivated when circulated through the hepatic portal system (*12*). Furthermore, the intrinsic production of gonadotropins is increased subsequent to castration, as determined by urinary or hypophyseal bio-assays, or in experimental parabiosis of an intact with a castrated animal (*4*). The role of the intrinsic gonadotropic hormones of the pituitary gland in tumor formation could thus be studied by the transplantation of gonads into the spleen or other sites drained by the portal vein. Biskind and Biskind (*2*) reported that three ovarian and one testicular tumors developed in gonads transplanted into the spleens of castrated rats, although Lipschütz, *et al.* (*7*) observed only growth of lutein cells in guinea pigs under similar circumstances. This paper is a report of tumors in intrasplenic ovarian transplants in castrated mice.

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[1] This research has been aided by grants from the Anna Fuller Fund and the Jane Coffin Childs Memorial Fund for Medical Research.

Inbred mice of the Strong A and C_3H strains[2] and hybrid mice (AC_3, AC_4)[3] were used. Six groups of experiments were set up (Table 1). Castration and grafting were done when the mice were one to three months old, except in the group bearing intratesticular transplants, in which a few mice were operated on at 130 days of age. The donors of the ovaries for the homo-or heterotransplantations were usually younger than the recipients. All experimental animals received no treatment other than that mentioned.

growth observed in a subcutaneously transplanted ovary in a castrated female mouse. The mouse was the only one that was operated on during pregnancy.

Most of the ovarian tumors protruded from the surface of the spleen; the largest measured 5 x 8 x 9 mm. in diameter. The tumors usually had a smooth, reddish-yellow surface, and some showed few scattered hemorrhagic follicles as indicated by dark red spots. On microscopic examination, most of the tumor cells of the granulosa-cell tumors appeared indistinguishable from the granulosa cells of the normal Graafian follicle, and mitoses were frequent. The ovarian tumors usually contained small and medium-sized, somewhat distorted cavities that were sometimes filled with blood cells or a few degenerating cells, and many solid masses or granulosa-like cells. The cells of the latter structures either were arranged in delicate, sinuous, single-celled cords or, in some places, assumed a trabecular appearance. Thus, the granulosa-cell tumors were preponderantly diffuse and folliculoid in pattern, as featured by Barzilai (*1*) in human material. The luteomas were composed of lutein-like cells arranged to form numerous small, tubular or cord-like structures, each surrounded by a delicate connective tissue septum. Sinusoidal blood capillaries and pigment containing cells were observed frequently among the luteinized tumor cells in some areas. Mitoses of the luteomatous cells were rare. In the mixed tumors there were transitional areas between the granulosa-cell and luteomatous types of tumor cells, which indicated that the luteomas were derived from luteinization of the granulosa cells of the tumors. In general, the histological features of the ovarian tumors were similar to those described by previous workers in the ovaries of X-rayed mice (*3*, *5*, *6*, *11*).

TABLE 1

TUMORS IN OVARIES TRANSPLANTED TO CASTRATED MICE

Site of transplant	Hosts	No. of mice	Tumors*			
			Granulosa cell	Luteoma	Mixed	None
Spleen	Castrated males	21	5 (224–268 days) 2? (130–262 days)	0	1 (225 days)	13 (75–268 days)
Spleen	Castrated females	33	0	4 (153–284 days)	7 (266–346 days)	22 (25–334 days)
Spleen (adhesion)	Castrated females	19	0	1 (262 days)	0	18 (95–346 days)
Subcutaneous	Castrated females	25	1? (243 days)	0	0	24 (61–278 days)
Subcutaneous	Intact males	12	0	0	0	12 (141–239 days)
Subcutaneous	Castrated males	9	0	0	0	9 (64–233 days)
Testis	Intact males	25	0	0	0	25 (32–353 days)

* The age of the transplant is given in parentheses.

Five granulosa-cell tumors, two probable tumors of the same type, and one mixed tumor consisting of both granulosa and luteomatous cells were found among the 21 castrated male mice with intrasplenic ovarian transplants. Four luteomas and seven mixed tumors were found among the 33 castrated female mice that showed no adhesion of the intrasplenic ovarian graft to the left uterine horn or to the adjacent peritoneum. Among the 19 castrated female mice with vascularized adhesions of the ovarian transplant, one luteoma was observed in a mouse that had irregular estrous cycles during the latter part of the experimental period. Mice of the A strain were used in these two groups of experiments, and most of the ovarian tumors developed in castrated mice carrying the intrasplenic ovarian transplants for more than seven months. No ovarian tumors were found in other sites of transplantation except for one small granulosa cell tumor-like

The prostates and seminal vesicles of the castrated male mice with intrasplenic ovarian transplants were atrophic. Only three castrated female mice having tumors of the intrasplenic ovarian transplants showed estrous vaginal smears, two early and one in the later part of the experiment. No estrous smears were obtained from the other eight ovariectomized mice that had tumors in the intrasplenic ovarian transplants; their uteri were small, averaging about 37 mg. A detailed description of the histological findings, together with the physiological effects, of the ovarian grafts and ovarian tumors induced in the present experiments will be reported elsewhere.

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[2] These mice were supplied by Dr. L. C. Strong.

[3] AC_4 are first-generation hybrid mice of the following parentage: C_3H (low-tumor) ♀ X A ♂. AC_3 are first-generation hybrid mice of the parentage: A (low-tumor) ♀ X C_3H ♂.

It is of especial interest that the pure granulosa-cell tumors and luteomas developed only in the castrated male and female mice, respectively, bearing the intrasplenic ovarian transplants. This may be due to structural and physiological differences in the pituitaries of male and female mice similar to those observed in rats (*8*).

Experimental induction of ovarian tumors in mice following X-ray irradiation has been reported previously (*5*, *6*, *11*), although no explanation as to the cause of the neoplastic formations was given. Because the histological structure of granulosa-cell tumors and the luteomas appearing in the ovaries transplanted into the spleen were similar, if not identical, to the ovarian tumors induced with roentgen rays, it seems that the same mechanism, namely, gonadotropic overaction, might be responsible for the tumors under both circumstances.

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Human Amino Acid Requirements

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A recent report (*2*) from Mitchell's laboratory presented data from which were calculated the requirements of normal young adult female humans for nitrogen balance for three different proteins: milk, soy flour, and white flour. From these figures and the analytical data summarized by Block and Bolling (*1*) it is possible to follow the pattern of estimation described by Stare, *et al.* (*3*) for egg protein, and calculate some of the individual amino acid requirements for humans on these bases.

For convenience of comparison, Mitchell's protein requirement figures for nitrogen balance, based on a 59.55-kg. female subject consuming a total of 1,300 calories, were extrapolated linearly to 70-kg. subjects. The corresponding data of Stare's estimate, which so far lacks experimental verification, are included in Table 1, while the calculated results for the individual amino acids are given in Table 2.

Theoretically, such calculations should have validity only if the biologic value of the protein is essentially unity. The fact that agreement is quite good, despite the wide range of biologic values reported by Mitchell (0.41–0.74), suggests that biologic value may be determined largely by the "essential" amino acid content, and the fraction of absorbed nitrogen excreted in the urine (which reduces the biologic value from unity) may merely reflect the excess of "nonessential" amino acids which cannot be utilized for lack of the necessary quantity of "essentials."

TABLE 1

Human Protein Requirements for Nitrogen Balance

Protein	Grams required for equilibrium in females (59.55 kg.) on 1,300-cal. diets (N × 6.25)	Coefficient of true digestibility	Grams protein corrected for digestibility* for 70-kg. individual (N × 6.25)
Milk†	22.4	0.94	24.7
Soy flour†	23.4	0.92	25.3
White flour†	38.7	0.97	44.1
Egg‡	—	1.00	28.0

* For the purpose of these estimates it is assumed that the effect of digestibility is the same on all amino acids. Since the digestibility figures are close to unity, the error thereby introduced is not likely to be greater than the various experimental errors in the analytical data, etc.

† Mitchell's data.

‡ Stare's estimate.

TABLE 2

Human Amino Acid Requirements for Nitrogen Balance
(Grams/day)

	Protein source				Minimal quantity
	Milk	Soy flour	White flour	Egg	
Arginine	1.2	1.5	1.7	1.8	1.2
Cystine	0.8	0.2	0.8	0.5	0.2
Histidine	0.7	0.6	1.0	0.5	0.5
Isoleucine	1.3	1.2	1.6	1.3	1.2
Leucine	3.0	1.7	5.3	3.6	1.7
Lysine	1.8	1.4	0.8	1.4	0.8
Methionine	0.5	0.5	1.3	1.4	0.5
Phenylalanine	1.5	1.4	2.4	1.4	1.4
Threonine	1.1	1.0	1.2	1.2	1.0
Tryptophane	0.5	0.4	0.4	0.4	0.4
Tyrosine	1.3	1.0	1.7	1.0	1.0
Valine	1.4	1.1	1.5	1.3	1.1

Of particular interest is the relatively good agreement of these several estimates. Most striking, perhaps, are the relatively low quantities of cystine and methionine in the case of soy flour and of lysine in the case of white flour. Bearing in mind the well-known observation that lysine seems to be the limiting amino acid in the utilization of white flour by the growing rat, it is not surprising that more of that protein is required for balance than either milk or soy flour. Table 2 also reflects this state of affairs by offering, in every other case except tryptophane, substantially more of the individual amino acids at balance level for white flour than for the other proteins studied. It would appear, then, that the lysine and tryptophane contents of white flour are perhaps limiting factors in human protein metabolism also.

The values recorded here must be regarded as purely approximate because of the lack of rigorous definition of the proteins studied and also because of the uncertainties associated with the analytical figures used for the calculations, as well as the effects of digestibility coefficients and biologic values more or less removed from unity. The effect of considering these figures in the light of protein requirements for what Mitchell calls true maintenance and "adult growth" has yet to be determined. Nevertheless, they may serve as useful approximations for interim purposes. The last column of Table 2 lists the minimal quantities of each amino acid so far adduced as required for maintenance of human nitrogen balance.

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Sex Produced in the Protozoa of *Cryptocercus* by Molting

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Twenty-five species of flagellate protozoa live in the hind gut of the wood-feeding roach, *Cryptocercus punctulatus* (*1*). They represent a varied assortment of organisms, ranging from small, fairly simple cells to large, complex ones, and comprise 2 orders, 8 families, and 12 genera. They all exhibit some form of sexual behavior when their host molts, but between molts there is no sexual behavior, they have the haploid number of chromosomes, and division is mitotic. However, under the influence of molting, their chromosome number is doubled, and they remain diploids until two meiotic divisions convert them again to haploids. But this reversible process of mitosis to meiosis does not occur in all of them at the same time: some begin it in the early stages of molting, finishing two or three days before the exoskeleton is shed; others do not begin it until 10–15 hours after the exoskeleton is shed and do not complete it until two to three days later. Also, they do not all employ the same method in changing from haploidy to diploidy.

The sexual process is fertilization in *Trichonympha*, *Leptospironympha*, and *Eucomonympha*, but in each genus there are interesting fundamental differences in the details of the process. In *Trichonympha* gametogenesis occurs within cysts, each gametocyst producing two gametes. In *Eucomonympha*, no cysts have been seen, and the method by which the gametes are formed is unknown. In *Saccinobaculus*, *Barbulanympha*, etc., other processes occur.

In *Trichonympha*, both gametes are the same size, but there are very definite, easily recognized differences between them before fertilization begins; and sometimes these differences may be seen before excystation, although they are usually not evident until later. The female or egg has an area of clearly defined, large, dense granules embedded in a jelly-like matrix. This area lies in the posterior end of the body and occupies about one-tenth of the entire cell. There is a clear, open space in the center of the area into which the male or sperm, which has no area of specialized granules, inserts its somewhat pointed, anterior, rostral end when fertilization begins. In a comparatively short time very firm contact is made between the gametes, and from this point on the egg plays the active role by ingesting the entire cytoplasmic and nuclear contents of the sperm. Soon after ingestion is complete, the extranuclear organelles of the sperm begin to disintegrate. First the nuclear sleeve, the outer and inner caps, and the postrostral flagella go, then the rostral flagella and the parabasals, leaving only the rostral tube, the rostral lamella, and the two centrioles (a long one and a short one at interphase). In the meantime the sperm nucleus becomes free to move, because of the disintegration of the extranuclear organelles holding it in position. It moves toward the egg nucleus, which is not free to migrate because those organelles which keep it in place, like the others of the egg, do not disintegrate. The membranes of the two nuclei touch each other and soon join so firmly that it is impossible, in living material, to separate one from the other without destroying both nuclei. Their chromosomes, which can be seen clearly in the living state, come closer and closer together, and an attraction between homologues is plainly evident. Complete nuclear fusion results, and the two groups of chromosomes become one group, all lying in a common, enlarged nuclear membrane. By this time, or shortly thereafter, the remaining extranuclear organelles of the sperm (rostral tube, rostral lamella, and centrioles) begin to disintegrate and soon disappear. Now a duplication of the male and female chromosomes occurs, and they enter the first meiotic prophase. As they shorten, synapsis and tetrad formation occur. At this point, the centrioles of the egg produce an achromatic figure which functions to separate the shortened, rod-shaped, metaphase chromosomes into two groups, the chromosomes going to the poles as dyads. This is the first meiotic division, and the second, which follows quickly—before the chromosomes have time to divide—is as typical as the first. This returns the chromosomes to the haploid condition.

In *Leptospironympha*, no cytoplasmic differentiation in the gametes has been seen, but their nuclei are clearly differentiated into male and female. As in *Trichonympha*, one gamete begins to enter the other, is ingested, and loses its extranuclear organelles. Nuclear fusion and zygotic meiosis are as in *Trichonympha*. However, *Leptospironympha* differs markedly from *Trichonympha*, in that its gametes are quite unlike the ordinary (somatic?) cells from which they arise. They have only the short rostral portion of flagellar bands. The two long spiral portions, which in nongametic cells extend from the anterior to the posterior end, are absent. The lack of these heavy, rather rigid bands obviously greatly facilitates the entrance of the sperm and the cytoplasmic union of the two cells.

In *Eucomonympha* one gamete does not enter the other; the two join in a manner similar to conjugation in ciliates, although the process is not conjugation in any sense of the word. When the gametes first come together, only a small portion of their surfaces is joined, and they present a picture like that of very late cleavage; later, after joining more completely, they present a picture closely resembling early cleavage. Finally, the furrow between their joined surfaces disappears, and what was once two separate cells now looks exactly like a larger but single cell except for the presence of two nuclei and two rostra. In the early stages of cytoplasmic fusion, the rostra, each with a nucleus held in a fixed position at its base, point more or less in the same direction; however, as fusion progresses, the rostra move in opposite directions, finally taking up positions at opposite ends of the zygote. If the situation is examined more closely, it will be seen that the male gamete which, like the female, has flagella over its entire body except for a very small area at the posterior end, began to lose its flagella about the time the furrow between the fusing gametes disappeared. This process continues until the axostyles and all the flagella with the exception of those on the small, anterior, rostral portion of the body disappear. At this time, or slightly earlier in some instances, the nucleus of the male gamete becomes free of its fixed position at the base of the rostrum and begins to migrate toward the nucleus of the female gamete, which, since *Eucomonympha* is a very large cell, may lie 200–300 μ away. However great the distance may be, the male nucleus succeeds in making contact with the female nucleus, which never moves from its fixed position at the base of the rostrum of the female gamete. By the time the nuclei begin to fuse, or thereabouts, the rostrum, lamella, and centrioles of the male gamete are extruded from the cell, pinched off with the loss of practically no cytoplasm. As in *Trichonympha*, the female gamete never loses any of its organelles, while the male loses all except the nucleus.

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[1] Some of this work was done at the Mountain Lake Biological Station of the University of Virginia. It was aided by a grant from the Penrose Fund of the American Philosophical Society.

In the large polymastigote *Saccinobaculus*, the process is autogamy and begins by simultaneous division of many of the nuclei. The daughter nuclei may move a considerable distance apart in the cell and return to the interphase condition, yet the cytoplasm makes no effort to divide. When the nucleus divides, the flagella and the very large, broad, heavily staining axostyle are discarded and renewed, one new set being produced for each nucleus. This occurs three to five days before the roach sheds its exoskeleton, and the cells remain in this condition for one to two days. Then the posterior ends of the axostyles begin to move together. This process continues until the axostyles lie side by side, from end to end, so closely that one has to look carefully to see that two are present. Since the nuclei are securely anchored to the axostyles near their anterior ends, this brings them close together, and fusion follows, but not immediately. It usually occurs shortly before the roach sheds its exoskeleton, or about two days after daughter nuclei and axostyles come together. It should be noted that *Saccinobaculus*, unlike the three genera already considered, does not lose its extranuclear organelles when the nuclei fuse, but at a considerably later time. The duplication of chromosomes occurs 10–20 hours after nuclear fusion. This is followed by synapsis, formation of tetrads, first and second meiotic divisions. Since the extranuclear organelles do not begin the process of disintegration until the prophase of the first meiotic division, and a long time is required for the large, heavily staining axostyle to be dissolved, the presence of two of these structures, instead of one as in all other divisions, serves as a perfect label for the first meiotic division.

Since the processes occurring in *Barbulanympha* and related genera supply valuable information on the origin and evolution of meiosis, these will be dealt with in another paper.

The writer does not know whether the effect of the molting fluid of the roach on the protozoa is direct or indirect, although the experiments carried out so far suggest that it is direct. Withholding of food, addition of CO_2, and removal of some O_2, conditions present at molting, fail to produce any of these sexual phenomena. However, irrespective of whether the effect is direct or indirect, the results set forth here indicate that the evolution of sexual and asexual phases in the life cycles of protozoa began as an environmental response.

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Hexosediphosphoric Acid in Living Yeast

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Some years ago, Deuticke and Hollmann (*1*) made the sensational report that they had been unable to find hexosediphosphoric acid in the intact muscle. The role of hexosediphosphate as an intermediate in the normal glycolysis was thus again made questionable, and by workers of great authority. Almost simultaneously Macfarlane (*3*), however, showed hexosediphosphate in the living brewer's yeast, where its amount increases during fermentation—a result which Rapoport (*5*) had been unable to obtain two years earlier. Considering the fundamental role of hexosediphosphoric acid in the Embden-Meyerhof-Parnas scheme, it was deemed necessary to reinvestigate the problem, especially as it has been continuously under discussion (*4*). We have therefore made some determinations on baker's and brewer's yeast according to Young's principle as adapted by Deuticke and Hollmann (*1*). According to our control tests, glucose-1-phosphate does not interfere.

TABLE 1

	Hexosediphosphoric acid Total P content γ/1 gram dry weight	
	Fresh yeast	Fermented 15 min. at + 20° C.
Baker's yeast	12	124–125
Brewer's yeast	5–8	49–86

To 700 (1,000) ml. fermenting solution, including about 0.5 kg. baker's (brewer's) yeast and 35 (50) grams glucose, 150 (210) ml. ice-cold 50 per cent trichloroacetic acid were added in order to stop fermentation. After standing 20 minutes in ice water, the solution was centrifuged. The liquid was freed from nucleotides according to Kerr (*2*) by precipitation with mercuric acetate. The hexosediphosphoric acid was then separated, according to Macfarlane (*3*), as the acid barium salt at pH 3.6 by an addition of 3 vols. alcohol. This was repeated after the removal of inorganic phosphate by magnesium mixture, whereupon it was reprecipitated at pH 8.2, adding .1 vol. alcohol. Determinations on resting yeast were made in the same manner, only without sugar.

The results are compiled in Table 1.

When hexosediphosphoric acid was precipitated only twice, for the first time as the acid barium salt at pH 3.8 and a second time as the neutral salt at pH 8.2, and when removal of inorganic phosphate was omitted, the results were as indicated in Table 2. These values may also more truthfully describe the quantitative proportions of hexosediphosphoric acid in both yeasts.

TABLE 2

	Hexosediphosphoric acid Total P content γ/1 gram dry weight	
	Fresh yeast	Fermented 15 min. at + 20° C.
Baker's yeast........................	62	214
Brewer's yeast........................	57	568

Yeasts employed contained few dead cells, the baker's yeast less than 0.5, per cent and the brewer's yeast 1.8–2.6 per cent.

Hexosediphosphoric acid must accordingly be considered as a normal intermediate in the fermentation of sugar both by baker's and brewer's yeast, even in an undestroyed fermentation system.

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Inactivation of Penicillins G and K by Liver and Kidney

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It has been shown (*1*, *2*) that penicillin K disappears more rapidly from the blood of rabbits and men than do penicillins G, F, and X in comparable dosage. It has also been stated (*1*) that the recovery of penicillin K in the urine of rabbits and men was 30–35 per cent as compared with an average recovery for G, F, and X of 74 per cent in rabbits and 91 per cent in men. In agreement with these data, the curative dose for experimental rabbit syphilis has been found to be very much greater for penicillin K than for the other penicillins (*1*). Eagle and Musselman have ascribed the rapid disappearance of penicillin K from rabbit blood and its comparatively low recovery in the urine to its inactivation by a "relatively thermolabile, nondialyzable constituent of plasma." The following experiments were undertaken in an effort to discover whether or not the liver plays a role in the inactivation of penicillin K.

Crystalline penicillins K and G were used in these experiments.[1] These compounds were characterized by carbon, hydrogen, and nitrogen analyses and by determination of the subtilis-staphylococcus ratios. The assays for penicillin were made by a modification of the Rammelkamp method (*5*). In some of the *in vivo* studies and in the *in vitro* experiments intermediate dilutions were made to detect small differences in penicillin concentration.

Rabbits anesthetized with sodium pentobarbital were used in the first phase of this study. Initially the rate of disappearance from the blood of penicillin K as compared with penicillin G was determined in renal-ligated preparations. In harmony with previously published reports (*1*, *2*), penicillin K was found to disappear from the circulating blood far more rapidly than penicillin G (Table 1).

TABLE 1

PENICILLIN LEVELS IN BLOOD OF RABBITS TWO HOURS AFTER THE INTRAVENOUS ADMINISTRATION OF 1,000 O.U./KG. OF PENICILLIN G OR K

Penicillin G O.U./ml. of blood		Penicillin K O.U./ml. of blood	
Eviscerate, renal-ligated	Renal-ligated	Eviscerate, renal-ligated	Renal-ligated
7.5*	5.0	2.50	0.312
7.5*	2.5	2.50	0.156
5.0	5.0	2.50	0.156
5.0	2.5	1.25	0.156
2.5		1.87*	0.156
2.5			
2.5			
Mean 4.64	3.75	2.12	0.187
S.E. ±0.84	S.E. ±0.72	S.E. ±0.25	S.E. ±0.031

* Obtained by modifying the Rammelkamp method to include intermediate values in the usual geometric progression of serial dilution.

The disappearance rates of penicillins G and K were then compared in renal-ligated, eviscerated preparations. The dose of penicillin was 1,000 O.U./kg. of intact body weight as in the first experiment. The results, as shown in Table 1, suggest that the evisceration procedure slowed the inactivation of penicillin K considerably, although the rate of disappearance of penicillin K in the renal-ligated, eviscerated preparations may have been more rapid than the rate of disappearance of penicillin G under the same circumstances. In this connection it should be noted that in the eviscerate preparation used in this study the liver was allowed to remain in the animal with patent hepatic veins, and therefore the animals may have retained some residual liver function (*4*). This interpretation of the data is strengthened by studies of surviving liver slices under anaerobic conditions, to be reported below.

Experiments were undertaken to test the ability of surviving rabbit liver slices to inactivate penicillins K and G *in vitro*. In each experiment approximately 100 mg. wet weight of liver slice were suspended in 3 ml. of Krebs and Henseleit (*3*) phosphate buffer (pH 7.4) containing 0.5 O.U./ml. of either penicillin K or G and 200 mg. per cent of fructose. The Q_{O_2} of the tissue was determined by the direct method. The flasks were filled with oxygen, incubated at 37.8° C., and shaken for 90 minutes at a rate of 120 per minute in a Barcroft-Warburg apparatus. A comparison of the inactivation of penicillin K with that of penicillin G under the same circumstances (Table 2) reveals that the total change in 90 minutes in penicillin K/100 mg. of liver tissue was 0.713 O.U., whereas the corresponding mean figure for penicillin G was 0.18 O.U.

Subsequent experiments showed that 1.05 O.U. of penicillin

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[1] The pure penicillin fractions were kindly supplied to us by Dr. W. C. Risser, Bristol Laboratories, Inc.

K was inactivated in the presence of 100 mg. of kidney tissue aerobically. Smaller but appreciable amounts of penicillin G apparently disappeared from the buffered solution in the presence of surviving kidney slices. Further studies revealed that the inactivation of penicillin K by liver and kidney slices occurs in an atmosphere of nitrogen as well as aerobically. The oxygen uptake by the tissue slices suspended in penicillin K-containing buffer was exactly the same as that observed in the case of the slices in penicillin G buffer.

TABLE 2

DISAPPEARANCE* OF PENICILLINS G AND K FROM MEDIUM IN THE PRESENCE OF SURVIVING LIVER AND KIDNEY SLICES

Tissue	Liver			Kidney		
Gas	O_2		N_2	O_2		N_2
Penicillin	K	G	K	K	G	K
	0.60	0.27	0.60	1.05	0.60	0.75
	0.75	0.27	0.60	1.05	0.60	0.75
	0.75	0.27	0.60	1.05	0.60	0.75
	0.60	0.27	0.93	1.05	0.27	0.51
	0.60	0.0	0.93	1.05	0.27	0.51
	0.60	0.0	0.93	1.05	0.27	0.75
	1.02		0.75			
	0.75		0.75			
	0.75		0.90			
Mean........	0.713	0.18	0.77	1.05	0.433	0.67

* Disappearance is calculated as O.U./100 mg. of wet weight of tissue. Triplicate analyses on individual rabbits are grouped.

Additional studies are now in progress to determine whether penicillin K is inactivated by other tissues, and whether intact liver and kidney cellular structure is essential for the effect noted above.

Summary. The inactivation of penicillin K is more rapid in the renal-ligated rabbit than in the renal-ligated, eviscerate preparation. Inactivation of penicillin K occurs in the presence of surviving liver and kidney slices. Small amounts of penicillin G were inactivated by liver slices; larger amounts disappeared in the presence of kidney slices. The inactivation of penicillin K in the presence of rabbit liver and kidney slices is demonstrable anaerobically as well as aerobically.

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IN THE LABORATORY

Measurements of Underwater Noise Produced by Marine Life[1]

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That certain fish species make noise under water has been common knowledge among fishermen since ancient times. For at least a century, observations on this phenomenon have been published by naturalists and zoologists. Until recently, however, all observations upon noise produced in this way were incidental and qualitative. No physical measurements of its frequency distribution or intensity are reported anywhere in the biological literature. It was not until the recent war that a need was felt for exact quantitative data on biological water noise. The introduction during the war of underwater acoustic equipment, such as listening devices, submarine detecting gear, acoustic mine mechanisms, and homing torpedoes, raised questions as to the interference that might be expected from natural background noises in the water. For this reason, information was required on the nature and magnitude of the water noise to be expected at various localities and under various conditions. Since no data of the type needed were available in the general literature, it was necessary for war research agencies working in underwater sound to make their own measurements. A large body of data was accumulated in this way which should considerably augment previously available knowledge of natural water noise and its production.

Although waves, wind, and tidal currents give rise to a measurable amount of water noise, this is seldom of a higher order of magnitude than 1 dyne/cm.^{2} in an octave band and is usually much lower. Biological sources, on the other hand, can be responsible for sustained noises with an octave pressure of several hundred dynes per square centimeter.

MEASUREMENT OF NATURAL WATER NOISE

The Naval Ordnance Laboratory carried on background measurements at several field locations where biological noises were particularly intense, and it has recorded the highest natural water-noise levels that have been observed anywhere. At the same time, a systematic effort was made to identify the species giving rise to the different kinds of fish noises recorded. This involved elaborate tests on segregated fish species, both in aquaria and in experimental ponds.

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[1] The field measurements and data reductions upon which this report is based were carried on by the following staff members of the Naval Ordnance Laboratory: L. G. Swart, G. E. Brown, L. C. Bell, D. L. Bobroff, R. F. Grunwald, G. R. Irish, W. E. Loomis, and the author. The consulting biologist for much of the work was Cdr. Charles J. Fish, USNR, of the Mine Warfare Operational Research Group. Walter H. Chute, director of the John G. Shedd Aquarium, gave the Laboratory substantial cooperation in its measurements there, and H. F. Prytherch, director of the U. S. Fishery Biological Laboratory, Beaufort, North Carolina, generously granted use of facilities for the field measurements and segregation tests reported from that area.

Procedure. Underwater background noises were picked up at all locations by underwater hydrophones and recorded on discs which were later played through an octave analyzer into a series of Esterline-Angus tape recorders, each octave over the range 50–3,200 c.p.s. being recorded on a separate tape. Calibration was by 1-kc. signal corresponding to a known sound pressure injected into the hydrophone circuit. Spectra were calculated and plotted from the octave tapes. At the same time, the disc recordings were available for listening and identification.

The hydrophones were of the Brush C-21 rubber-covered crystal type or the RCA 2A condenser type with a Monel diaphragm. Each kind had preamplifier inside the case. Discs were made with RCA cutting heads operated through standard Brush or RCA recording amplifiers. Filters in the analyzing system were of the ERPI octave type. The recording system is designed to give mean rectified sound pressure instead of root mean square or peak pressure. For the case of impulsive noises, such as the drumming and grinding produced by fish, the peak noise would be some 40 per cent higher than the mean rectified signal.

DIRECT FIELD DATA

Disc recordings of underwater background noise in open water have been made by the Naval Ordnance Laboratory at various points along the East Coast of the United States from Florida to Cape May. During the course of these surveys, biological noise of many kinds has been heard and recorded. The measurements have been under a wide variety of circumstances as regards oceanographic conditions, season, time of day, etc.

Frequency Spectra. The large variation that can be expected in the background at a single location is illustrated in Fig. 1 by spectra obtained at typical locations along the East Coast. The ordinates represent the sound pressure observed within an octave band. These are plotted at the mid-band frequency of the octaves extending from 50 to 3,200 c.p.s., the points being connected by smooth curves. The two highest curves were recorded at Wolf Trap, in the middle of Chesapeake Bay, where the water depth is 40 feet. The spectra were both recorded in early July, but in successive years. The frequency characteristics are almost identical, although the 1942 level is about 60 per cent higher than the 1943. The frequency at which the peak noise level occurs is here observed at about 350 c.p.s. This is more than an octave lower than the peak recorded at Cape Henry in 1942, about five weeks earlier, which is the third highest curve in Fig. 1. The difference is probably attributable to the time interval between the two measurements rather than to their geographical separation. Since the source of noise in all cases was almost certainly croakers or other members of the Sciaenidae family, the fish would have grown longer during the intervening period and thus would produce resonant vibrations having lower pitch.

Of the other two curves, one was recorded in June 1943 at Fort Macon, North Carolina. The peak occurs at about 600 c.p.s., and the source is very likely to be croakers. The other was recorded from a boat in the open Atlantic, approximately 20 miles off shore, south of Cape Lookout, North Carolina. The noise here, although of the same character as that of croakers, is of much higher pitch than any Sciaenidae noise recorded elsewhere, the peak occurring at about 2,400 c.p.s. A search of the literature revealed that the bastard trout (*Cynoscion nothus*) is common off shore in this area but has not been observed near shore. This species, attaining a minimum length of 3 inches, is smaller than other drumfish along the United States east coast, and would thus be expected to produce a noise of higher pitch.

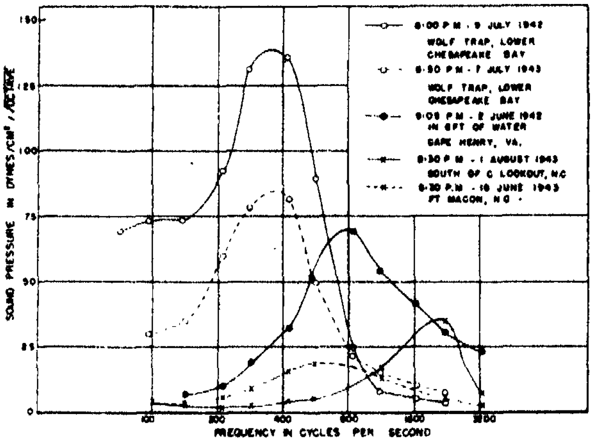

FIG. 1. Spectra of water noise caused by marine life at various points along the East Coast of the United States.

Seasonal variation. Distinct seasonal effects were observed in the water noise recorded in Chesapeake Bay. This variation was associated with seasonal movement of the croakers in the Bay. The daily maximum nocturnal noise levels at Cape Henry are plotted in Fig. 2 over the period from the middle of

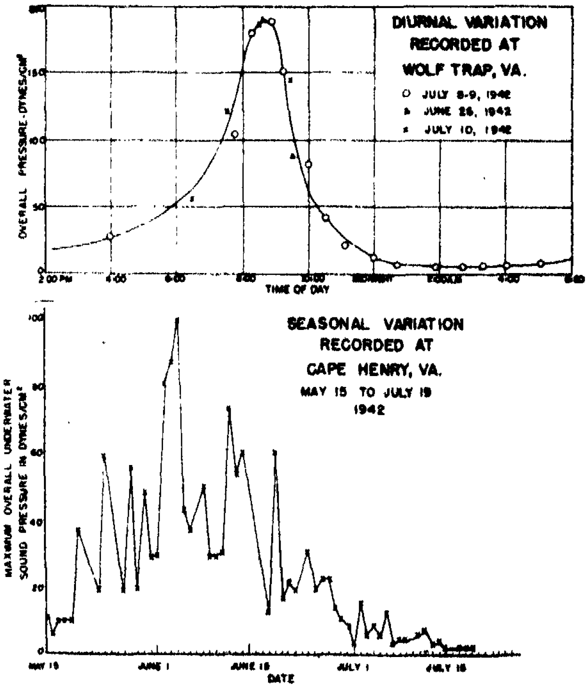

FIG. 2. Diurnal variation of water noise produced by marine life at Wolf Trap, Virginia, and seasonal variation of maximum daily water noise at Cape Henry, Virginia.

May to the middle of July. The peak of activity was during the early part of June, and by July 15 the activity was virtually over.

Diurnal effects. Diurnal variation in background noise level at Wolf Trap is also plotted in Fig. 2. The plot represents the composite of observations taken on three different days during the summer of 1942. Here the peak was reached at about 8:30 P.M., the curve being almost symmetrical around that time. At Beaufort and Fort Macon, North Carolina, the following year, the peak during June was reached at approximately 12:30 A.M. each night. The reason for this well-defined recurrent nocturnal appearance of the noise is not known definitely, although it is suspected that the peak coincides with feeding activity on the bottom.

STUDIES OF SEGREGATED FISH

Noises made by known fish species have been recorded and measured both at the Shedd Aquarium in Chicago and at the U. S. Fishery Biological Laboratory, Beaufort, North Carolina. The purpose of the tests in the aquarium was to determine which of the species in the collection was sonic, the conditions under which the sonic species could be induced to make noise, and the general nature of their noise. Although the noises were recorded on discs, it was not possible to measure absolute sound pressures or to make accurate frequency analyses. Most of the fish that produced noise in the aquarium belonged to families previously reported to be sonic in the biological literature. There were several species, however, for which no record of sound production could be found in the literature which turned out to be prolific noisemakers. Several members of the Pomacentridae family, such as the *Hypsypops rubicundus*, or garibaldi, of Southern California and the *Eupomacentrus fuscus*, or coral-reef fish, were among these, as were certain species of catfish.

At Beaufort, conditions of segregation were much more favorable for accurate quantitative measurement of fish noise. Species were put into separate enclosures set off by chicken-wire fence in a 75 x 85 foot experimental salt-water pond about 3 feet in depth, with a mud bottom. Hydrophones were planted in each enclosure. Fish were caught by commercial fishermen, who transported them to the experimental pond in a live car. The number of specimens investigated ranged from several hundred in the case of croakers to three in the case of sea robins. Results of the tests will be discussed briefly here. Fig. 3 shows the frequency characteristics of the various sonic species.

Croaker (*Micropogon undulatus*): The most common drumfish in the estuarine waters of the U. S. East Coast is the croaker, and this is believed to be responsible for the greatest part of the noise observed in the open-water tests previously discussed. Its noise consists of rapid drum rolls resembling the sound of an electric drill being driven into asphalt. This sound is made by the action of special "drumming muscles" against the fish's air bladder, which is set into resonant vibration at a frequency that should be inversely proportional to its length. In captivity, inside a wire-net enclosure, croakers made noise spontaneously but with noticeably less vigor and intensity than when observed under entirely natural conditions. The noise came in bursts consisting usually of only two or three drum beats of lowered pitch instead of the rapid, vibrant trill heard in open water. Noises were audible under water as much as 25 feet from the source, as was evinced by moving the hydrophone away from the croaker enclosure until the characteristic noise could no longer be distinguished.

Toadfish (*Opsanus tau*): Most remarkable of all fish studied in the current survey was the toadfish. A sluggish, ill-tempered, nest-building bottom dweller, this genus produces a much more intense noise than any other form of marine life investigated. The sound is an intermittent, low-pitched musical blast of about ½-second duration, somewhat similar to a boat whistle, and is concentrated at the low-frequency end of the spectrum, as shown in the typical curve of Fig. 3, which represents the noise emitted by a toadfish within a few inches of the hydrophone.

Unfortunately, the identification of this noise must be based on circumstantial rather than direct evidence. A direct identification was never possible, because no toadfish specimen would make noise in captivity. Hence, instead of following the usual procedure of capturing a specimen and inducing it to make noise, one first located the suspected noise in open water and tracked down its source. This was not difficult, because the characteristic musical sound was heard almost constantly, at least in the distance, wherever a hydrophone was lowered into the water. On moving the hydrophone toward the source of noise until maximum intensity was recorded, it was found that the source remained at one spot on the bottom for days at a time. This fact definitely suggested the toadfish as source, since it is the only sluggish species in this area.

To obtain direct proof, diving was tried but failed because of poor visibility. A baited crab trap was then lowered into the water at the point where the hydrophone indicated maximum noise. Shortly thereafter the blasts stopped for the first time in over a week; and when the trap was pulled up, it contained a toadfish.

Hogfish (*Orthopristis chrysopterus*): A close relative of the grunt, a common tropical offshore fish, the hogfish gets its name from the characteristic grunting noise it makes when taken from the water. This noise is produced by gnashing of the pharyngeal teeth and has a harsh, rasping quality. Under water the noise is made spontaneously in bursts of four or five rasps following each other in rapid succession.

The hogfish is common in the waters surrounding Beaufort, but its noise was heard only occasionally from the Fishery Laboratory Pier on Piver's Island or at Fort Macon. It was concluded on the basis both of tests at Beaufort and of previous aquarium studies that those fish making noise by gnashing of the pharyngeal teeth are not as important sources of underwater noise as those producing sound by action of the air bladder, viz., croakers and toadfish.

Spot (*Leiostomus xanthurus*): The spot, as a member of the Sciaenidae family, is closely related to the croaker, but its noise is of quite a different timbre. The sound might best be described as a series of raucous honks, having a volume level and frequency distribution typified in Fig. 3. Moving the hydrophone away from the enclosure containing the spot indicated that the noise was audible no more than 5 feet from its source, and hence is initially not as intense as that of the croaker.

Spot were heard occasionally around Piver's Island and in offshore waters around Cape Lookout, but the magnitude and character of the noise are such that it is not believed to be a significant contribution to the over-all background level in open water. Moreover, spot are reported to be solitary rather than gregarious, and hence sources of this noise would probably be dispersed.

Sea robin (*Prionotus carolinus*): The segregation tests on sea robins were not very satisfactory because specimens were seldom available, and the only recordings of their sounds were made in aquarium tanks rather than in the experimental enclosures. The noise of this species is so characteristic, however, that the aquarium tests made its identification in natural waters quite simple.

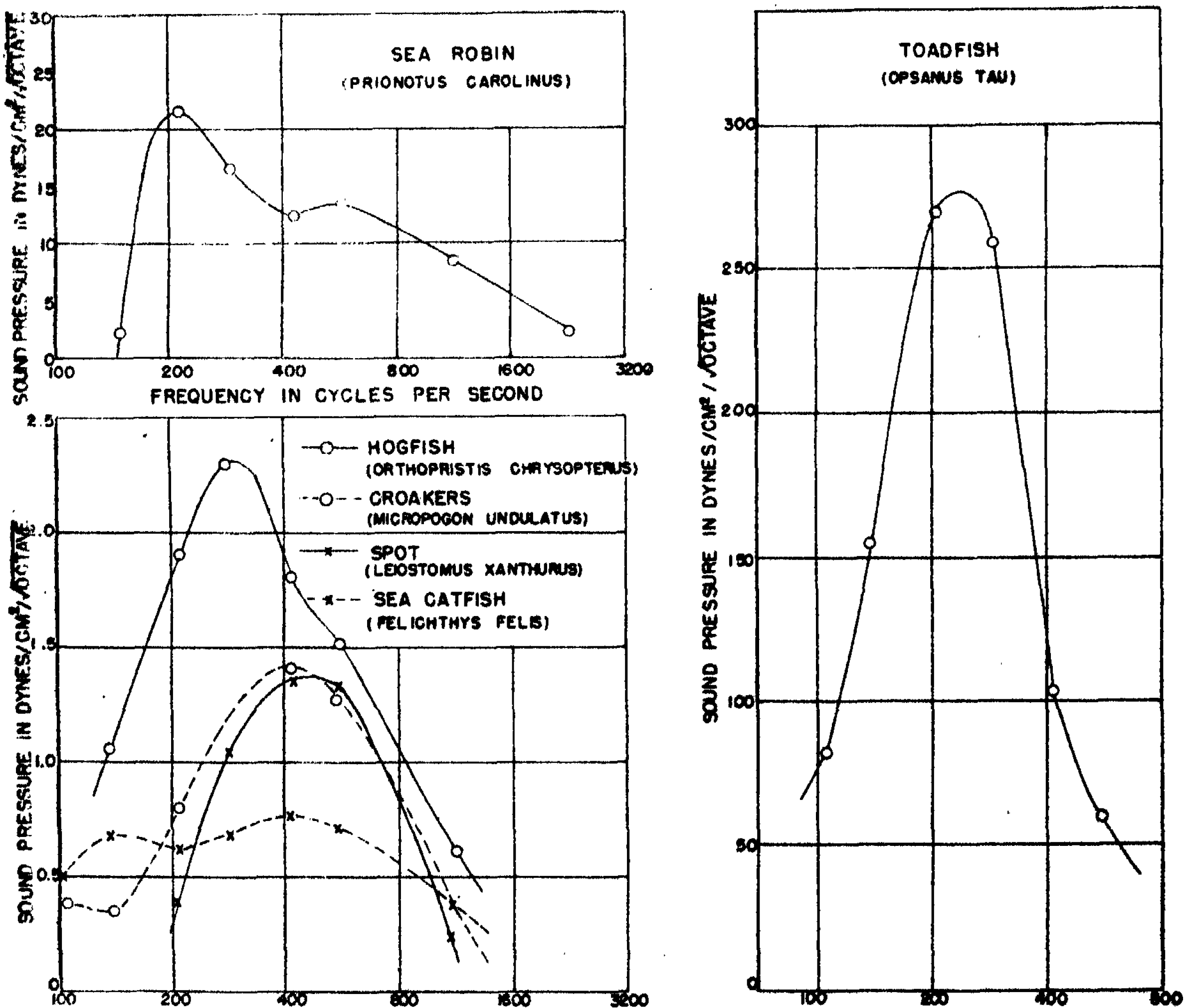

Fig. 3. Spectra of noise produced by segregated groups of sonic fish.

The sound of the sea robin might best be described as a modulated, rhythmic squawk, squeal, or cackle, resembling noises ordinarily associated with a barnyard. The curve in Fig. 3 gives the frequency characteristics and level for the case of a single specimen in a highly reflecting concrete pool.

Sea robin noises were frequently heard in the course of the open-water listening tests both at Piver's Island and Fort Macon, particularly at the latter location. They were also discernible during offshore listening tests past Cape Lookout. It was never possible in field measurements to determine sound levels due to sea robins alone, since they were always heard simultaneously with croakers and other sonic species.

The mechanism of sound production in the sea robin is, according to Tower (*1*), the same as that of the toadfish. The considerable difference between the noises, however, both in character and intensity, casts doubt upon the correctness of this observation.

Sea catfish (*Felichthys felis*): During the course of the segregation tests it was found rather unexpectedly that the common sea catfish is a significant noisemaker. It makes a rhythmic drumming noise like the beating of a tom-tom, differing from the drumming of the croaker in that it comes not in rolls but in rapid, evenly-spaced beats. This noise was heard under natural conditions at Fort Macon and in Bogue Sound, near Morehead City. For this study measurements were made on four catfish in an experimental enclosure.

The motivation for noise production by marine life lies outside the scope of this paper. Further light on it, however, should make possible a more substantial knowledge of behavior patterns in sonic species.

The disc recordings made in connection with water listening described above as well as in the tests on segregated fish are available in the Naval Ordnance Laboratory's files. Dubbings can be made available to any biological laboratory which can put them to use.

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Portable Glycol Vaporizers for Air Disinfection[1]

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The promising results of recent studies (*3, 5, 6*) on the use of propylene glycol and triethylene glycol vapors for air sterilization have created a need for portable and inexpensive glycol vaporizers for constant or intermittent use in small spaces such as operating rooms, two- or three-bed hospital wards, laboratories, classrooms, etc. Vaporizers in present use (*1, 4*) are suitable for large spaces, as dormitories, auditoriums, assembly halls, office and factory buildings. While they fulfill the requirements for generation of vapors at a constant rate, size and cost limit their use to relatively large installations.

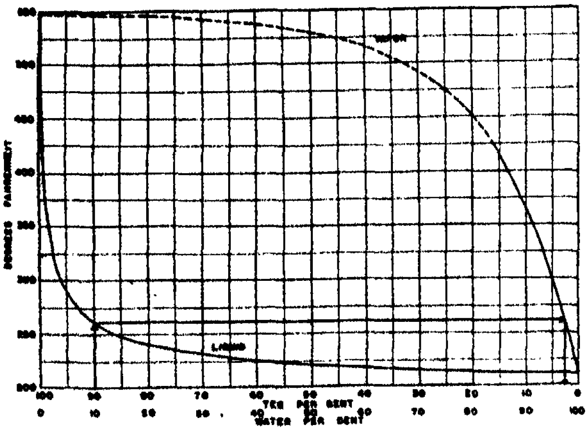

Fig. 1

From study of the temperature-composition diagram of glycol-water solutions (*Fig. 1*), it may be seen that the relative proportions of vapors emitted from a boiling mixture are dependent upon the concentration of the solution. The total vapor output will depend upon the heat input (rate of boiling). A method for controlling the concentration of the solution would, of necessity, determine the ratio of glycol and water vapor emitted. We have utilized two such control measures in the devices described below.[2] It should be pointed out that while only triethylene glycol (TEG) is mentioned in the description, the apparatus may also be used with propylene glycol (PG) if the different boiling temperature of PG is considered.

The portable vaporizer shown in Fig. 2 retains the essential features of the larger field model, but replaces the expensive and bulky thermoswitch-solenoid valve control system with a thermostatic bellows directly connected to a small valve. A low-pressure water line, which may be an aspirator bottle, is connected to the water inlet. The bellows is filled with a TEG-water solution in equilibrium with the desired concentration in the liquid container. For satisfactory operation, the bellows should be completely immersed and the valve must be above the surface of the liquid.

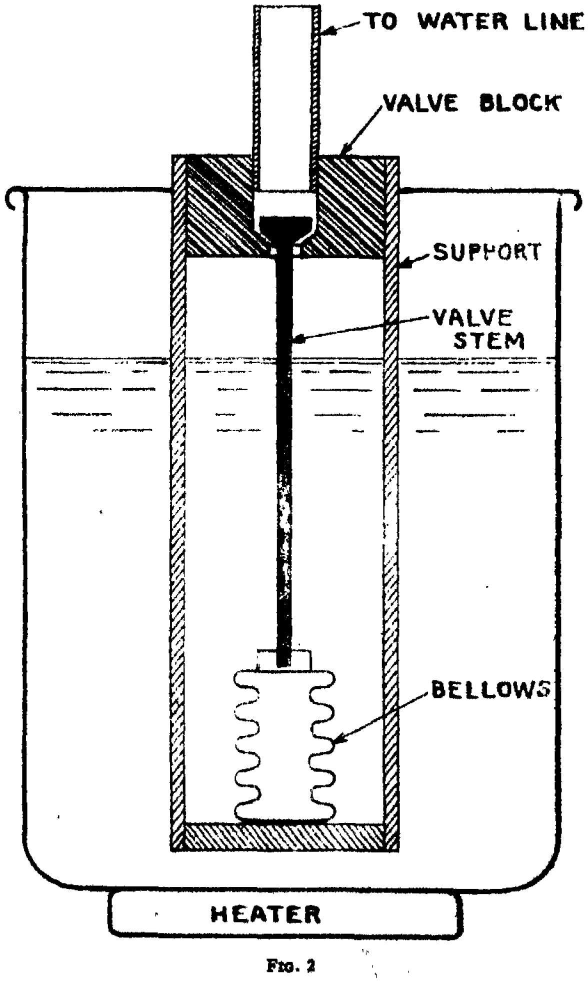

Fig. 2

The container has a capacity of approximately two quarts. It is preferably heated by a disk type three heat coil (100, 200, 400 watts) mounted beneath the vaporizer. An immersion heater may also be used, although it may not be quite as convenient.

To illustrate the mode of operation, assume we wish to vaporize TEG at 290° F. From the temperature-composition diagram, a solution of 4.7 per cent water and 95.3 per cent TEG boils at 290° F., and the corresponding water output is about 96 per cent water and 4 per cent TEG. The bellows is accordingly filled with a 95.3 per cent TEG solution and sealed.

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[1] This work described in this paper was done under a contract, recommended by the Committee on Medical Research, between the Office of Scientific Research and Development and Northwestern University.

[2] Patent applications made and assigned to Northwestern University.

A solution of the same composition is placed in the vaporizer. As heating progresses, the vaporizer TEG concentration increases, due to the loss of water, and consequently the boiling point of the liquid also rises. This rise in temperature vaporizes the solution in the bellows, causing it to expand and open the valve, admitting water into the solution. The added water lowers the boiling point of the solution, cooling the bellows, which then contracts and closes the valve. On continued heating this cycle is repeated, maintaining the concentration within close limits.

The vaporizer shown in Fig. 3 uses a modification of the well-known "chicken feeder" principle. A copper tube (about ⅛ inch inside diameter and 6 inches long) joins the vaporizer at a point about ½ inch below the desired liquid level to an open feed cup in which an inverted large-mouthed reservoir bottle is mounted. The purpose of the rather long tube is to prevent the heat of the vaporizer from boiling the liquid in the feed cup. The bottle is filled with a TEG-water solution of the same proportions as desired in the vapors to be given off by the vaporizer. For example, since the vapors from a boiling 95.3 per cent TEG solution will consist of 96 per cent water and 4 per cent TEG, if the reservoir is filled with a 4 per cent TEG solution, it will automatically replace in the vaporizer the proper quantities of water and TEG, since the feeder action acts as a constant-level device.

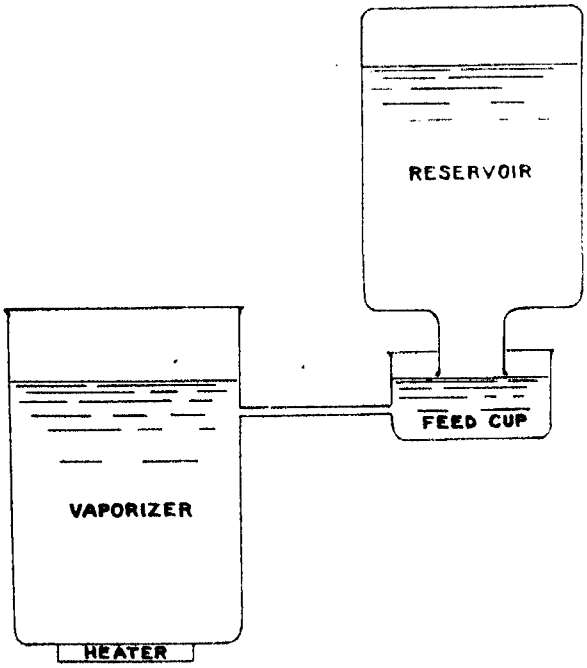

FIG. 3

It should be pointed out that even if the concentrations in the vaporizer and in the reservoir do not correspond to those in the temperature-composition diagram, the vaporizer concentration will approach a value determined by the reservoir concentration, so that eventually the two concentrations will correspond to those in the diagram. The reservoir concentration, however, is the controlling factor.

In permanent installations where glycol generators are connected to duct systems of known capacity or incorporated into air-conditioning systems, the necessary calculations to obtain an optimum TEG concentration of 0.003–0.005 mg./l. of air may be made with a fair degree of accuracy. Such a close control of concentration is not possible with the portable models herein described.

We would suggest that the vaporizer be placed in the room to be treated, either on the floor or on a table, in such a manner that air currents will distribute the vapors uniformly. A small, oscillating fan mounted behind the vaporizer may be helpful. The apparatus should then be turned on at high heat (400 watts) and allowed to operate until a slight fog becomes noticeable, at which time it is either turned to a lower heat or disconnected.

The space which may be treated by one of these devices will be dependent not only on its size but the degree of air infiltration and exfiltration which occurs within it. It is our feeling that a room of 15,000–20,000 cubic feet, under normal conditions, may be adequately treated, since the output at 400 watts is approximately 11 cc. TEG and 360 cc. water vapor per hour if the reservoir boiling temperature is 290° F. (95.3 per cent TEG). This output, of course, may be varied by altering the concentration of the boiling solution or changing the heat input. It will take individual adjustments and observations to adapt a vaporizer for a specific space, but these should be readily made.

These vaporizers offer the specific advantage over other suggested methods for glycol vapor generation by the simultaneous generation of water from a boiling aqueous solution. This serves two purposes, that of reducing possible fire hazards (*2*) and that of aiding in humidification.

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Scanning Science—

The new catalogue of Harvard University shows a registration of 3,674 students, an increase of 74 over last year. There has been a slight decrease in the College, but a gain in the Lawrence Scientific School, in the Graduate School and in the Medical School. There has been an increase of 4 professors and 17 instructors.

—January 1, 1897

Book Reviews

Mental disorders in later life. Oscar J. Kaplan. (Ed.) Stanford Univ.: Stanford Univ. Press, 1945. Pp. vii + 436. (Illustrated.) $5.00.

Within the last few years physicians, psychologists, sociologists, biochemists, and physiologists have come to see the importance of diseases peculiar to old age, and a large number of publications has appeared dealing with various aspects of the problem of geriatrics. It is obvious that these different phases of the subject are closely interrelated and must be considered in an integrated fashion if they are to bring positive results. It is gratifying, therefore, to see that the editor of this book has been able to enlist the aid of well-known authorities on the subject and has produced an integrated presentation of most of its important phases. As is always the case in contributions of this type, its separate chapters vary both in importance and quality of the presentation.

The most valuable of the chapters are those dealing with the physiological aspects of these diseases, the psychological investigations, the neuroses of later maturity, the psychoses occurring at this age, the psychosomatic problems, and the psychotherapeutic methods. It is interesting to note that in all of these there seems to be a consensus as to what constitutes the important nucleus of the problem, and we are impressed particularly by the following points:

(1) The maladjustments associated with old age are not so much dependent upon actual destruction of tissue as they are upon the disturbances in homeostasis.

(2) The disturbances in old age cannot be said to be due primarily to either organic changes or the impact of social problems but must be regarded as the result of a combination of both.

(3) Both the neuroses in general and the psychosomatic disturbances in particular, occurring at this age, may be of two types: those that are encountered at any age, and those that are especially characteristic of the later years.

(4) Finally, and perhaps the most hopeful feature as far as practical therapy is concerned, are the points brought out both in the chapter on neuroses and that on treatment—that psychotherapeutic efforts are definitely worth while and can be successful in old age.

Some of the chapters leave us with the feeling that not enough stress has been placed on points of importance. This is true, for instance, of the chapter on sociological aspects, where the broad social implications of age and the attitudes of society in general are not brought out as sharply as one would wish, and of that on the problems of nutrition in old age, which is entirely too short and too superficial to be of as much value as one would have expected.

Finally, there are two chapters that leave one with the question as to whether they really belong in this book. One is a chapter on older mental patients after long hospitalization, which in itself is an excellent contribution but has really not much bearing on the problem of aging. The other is the chapter on toxic deliria in which entirely too much space is devoted to the discussion of extraneous subjects and polemics.

There is a brief introduction by Dr. Karl Bowman which presents the general aspects of the problem and a very thoughtful concluding chapter by Dr. E. J. Stieglitz on systematic orientation. On the whole, the book makes a very good impression and is recommended to the reader as a very worthwhile contribution to the studies of personality disturbances in later maturity.

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Industrial and commercial geography. (3rd ed.) J. Russell Smith and M. Ogden Phillips. New York: Henry Holt, 1946. Pp. xiii + 978. (Illustrated.) $4.90.

Textbooks are so characteristically dull that it is a relief to read one which maintains a high level of interest for more than 900 pages. The volume surveys the industries of the world as they have been affected by the Power Age. In an undertaking so comprehensive, this is a feat worthy of note.

The effectiveness of the book must be attributed in large part to the authors' ability to write readable English. By vivid writing they succeed in convincing the reader that man's relation to his environment is a dynamic subject, not a static or dead concept.

Starting with a brief survey of energy sources and fundamental factors affecting manufacture, the authors describe in turn the great industries of the world for each continent. The fuels are presented first and are followed by iron and steel, other metals, and nonmetals. This sequence has the advantage of focusing attention on the basic industry, but has a disadvantage in that the topics of forestry, agriculture, animal industries, and fishing are apt to seem anticlimactic. Smith and Phillips avoid this pitfall by close integration between subjects and by stressing the perpetual nature of agriculture. The ultimate exhaustion of all mineral deposits emphasizes the fact that, historically, agriculture was the first industry developed, and in the final analysis it may prove to be the mainstay of civilization. It is possible that an historical approach, starting with agriculture and building up to the climax, the iron and steel industry, might have strengthened this tenet and added an element of suspense, thus giving greater unity to the volume.

The description of the world's resources and industries occupies 733 pages. The final section, which presents an analysis of world commerce, unfortunately contains the only conspicuously poor writing in the book. There are some involved sentences, and occasionally the authors' meaning is given a ludicrous connotation that certainly was never intended. For example, on page 813, appears the statement: "It (the reindeer) is a great aid to prospectors and miners in the search for minerals in which Alaska and northern Canada seem to be promising." The casual reader is left with the impression that the prospectors are using reindeer as super-bloodhounds for tracking down new mineral localities.

The chief criticism of *Industrial and commercial geography* concerns a fact that lies beyond the control of the authors, namely, consideration of the prewar period as the norm. Because of the dynamic nature of geography, it is doubtful whether conditions can revert entirely to their prewar state.

It is regrettable that the pictures are so poorly reproduced. The graphs and maps are numerous and generally illuminating. The information on some of the maps is so microscopic that it is undecipherable. The method of numbering illustrations by pages is highly commended, since this saves both the reader's time and temper.

This book should prove effective as a text, because of its wealth of information and its readability, and valuable as a reference to students of economics, sociology, and government as well as to geographers.

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La pathologie des oiseaux. G. Lesbouyries. Paris: Vigot Frères, 1941. Pp. 868. (Illustrated.) 1,000 fr.

The author of this work is a professor of veterinary medicine, and the title is likely to prove misleading to ornithologists seeking information on diseases of wild birds. Nevertheless, the book should receive notice outside its strict field because of its extremely detailed treatment of a broad range of infectious maladies, some of which are associated with manifestations in nature.

Dr. Lesbouyries calls attention to the fact that investigation of avian disease has been responsible for a number of important advances in the history of medicine. He then discusses, in order, malnutritions, tumors, infections (virus, bacterial, protozoan, fungus), malformations, glandular affections, endo- and ectoparasites, etc. Each disease which has received a name is minutely described in terms of symptoms and cellular pathology, and its history, treatment, and prophylaxis are adequately discussed, at least in so far as they relate to barnyard fowl. Mention of other birds is scanty, and references to parrots, crows, penguins, quail, falcons, eagles, owls, doves, magpies, larks, and finches seem to be drawn entirely from literature rather than from firsthand clinical esperience.

Despite its wealth of information for those who wish to search it out, nonmedical ornithologists will deeply regret the lack of a table of contents, an index, and a bibliography. Authors and the dates of their publications are cited in profusion, but the absence of a formal bibliography is excused on the ground that it would "submerge the text" of the huge volume.

The reader seeks in vain for accounts of spectacular pandemics among wild populations, such as the Peruvian guano fowl, the fulmars of the North Atlantic, and the wild ducks of the western United States, all of which have become the subjects of a considerable scientific literature.

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Scientific Book Register

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Elementary Theory of the Chain-reacting Pile

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THE RESULTS AND THE METHODS DISCUSSED in the following outline of the theory of a chain-reacting pile working with natural uranium and graphite have been obtained partly independently and partly in collaboration by many people who participated in the early development work on the chain reaction. Very important contributions to the theoretical ideas were given by Szilard and Wigner. Many physicists contributed experimental results that helped to lead the way, among them, H. L. Anderson and W. H. Zinn, first at Columbia University and later at the Metallurgical Laboratory of the University of Chicago; R. R. Wilson and E. Creutz, at Princeton; and Allison, Whitaker, and V. C. Wilson, at the University of Chicago. The production of the chain reaction was finally achieved in the Metallurgical Laboratory directed by A. H. Compton.

Absorption and Production of Neutrons in a Pile

We consider a mass, "the pile," containing uranium spread in some suitable arrangement throughout a block of graphite. Whenever a fission takes place in this system, an average number (ν) of neutrons is emitted with a continuous distribution of energy of the order of magnitude of 1,000,000 EV. After a neutron is emitted, its energy decreases by elastic collisions with the atoms of carbon and to some extent also by inelastic collisions with the uranium atoms. In the majority of cases the neutrons will be slowed down to thermal energies. This process requires about 100 collisions with carbon atoms. After the energy of the neutron is reduced to thermal value, the neutron keeps on diffusing until it is finally absorbed. In several cases, however, it will happen that the neutron is absorbed before the slowing-down process is completed.

The neutron may be absorbed by either the carbon or the uranium. The absorption cross-section of carbon for neutrons of thermal energy is quite small, its value being approximately $.005 \times 10^{-24}$ cm.^{2} For graphite of density 1.6, this corresponds to a mean free path for absorption of about 25 m. It is believed that the absorption cross-section follows the 1/v law, and consequently the absorption cross-section, which is already quite small at thermal energies, becomes practically negligible for neutrons of higher energy. It is therefore a sufficiently good approximation to assume that absorption by carbon during the slowing-down process can be neglected.

The absorption of a neutron by uranium may lead either to fission or to absorption by a (n, γ) process. We shall refer to this last possibility as the process of resonance absorption. The relative importance of fission and resonance absorption in the different energy intervals is not the same. In this respect we can consider roughly three intervals:

(1) Neutrons with energy above the fission threshold of U^{238}—We can call these conventionally "fast neutrons." For fast neutrons the most important absorption process is fission, which normally takes place in the abundant isotope U^{238}. Resonance absorption is smaller but not negligible.

(2) Neutrons of energy below the fission threshold of U^{238} and above thermal energy—We shall refer to these neutrons as "epithermal neutrons." For epithermal neutrons the most important absorption process is the resonance capture. The cross-section for this process as a function of energy is quite irregular and presents a large number of resonance maxima that can be fairly well represented by the Breit-Wigner theory. In practical cases the resonance absorption becomes important for neutron energy below about 10,000 EV and increases as the energy of the neutrons decreases.

(3) Neutrons having thermal agitation energy or "thermal neutrons"—For thermal neutrons both the resonance and fission absorption processes are important. In this energy range both cross-sections follow approximately the 1/v law, and therefore their relative importance becomes practically independent of the energy. Let σ_f and σ_r be the cross-sections for fission and resonance absorption for neutrons of energy kT, and η be the average number of neutrons emitted when a thermal neutron is absorbed by uranium. Then η differs from ν, since only the fraction $\sigma_f/(\sigma_r + \sigma_f)$ of all the thermal neutrons absorbed by uranium produces a fission. It is, therefore,

$$\eta = \nu\sigma_f/(\sigma_f + \sigma_r). \tag{1}$$

The preceding discussion leads one to conclude that only a fraction of the original fast neutrons produced will end up by producing a fission process. For systems of finite size, further losses of neutrons will be expected by leakage outside the pile.

Limiting ourselves for the present to systems of practically infinite dimensions, we shall call P the probability that a fast neutron ultimately is absorbed by the fission

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process. The average number of neutrons produced in the "second generation" by the first neutron will then be

$$k = P\nu. \qquad (2)$$

Usually, k is called the "reproduction factor" of the system. A self-sustaining chain reaction evidently is possible only when $k > 1$. If this is the case, the reaction actually will take place provided the leakage loss of neutrons is sufficiently small. This, of course, can always be achieved if the size of the pile is large enough.

LIFE HISTORY OF A NEUTRON

When a fast neutron is first emitted in our pile, the following events may take place:

(1) There is a small probability that the neutron will be absorbed by uranium before its energy has been appreciably decreased. If this is the case, the absorption leads often to fission of U^{238}. The probability of such fast fissions, however, is usually only a few per cent. Indeed, if the system contains little uranium and a large amount of carbon, the elastic collisions with carbon tend to reduce the energy very rapidly to a value below the fission threshold of U^{238}. If, on the other hand, the system is very rich in uranium, the inelastic collision processes become very probable and rapidly reduce the energy of the original fast neutron to a fairly low value before it has a chance to produce a fission in U^{238}.

(2) In the large majority of the cases, therefore, the neutron is not absorbed as a fast neutron and rapidly loses its energy, mostly due to collision against the carbon atoms. One can prove in an elementary way that it takes about 6.3 collisions against the carbon atoms to reduce the energy by an average factor of e. Consequently, it will take about 14.6 collisions in order to reduce the energy by a factor of 10, and about 110 collisions to reduce the energy from 1,000,000 EV to the thermal energy value of 1/40 v. While this slowing-down process is in progress, the neutron may be absorbed by the resonance process in uranium. We shall call p the probability that a neutron is not absorbed before reaching thermal energy. One of the most important factors in designing a pile consists in trying to minimize the probability that neutrons are removed from the system by resonance absorption during the slowing down.

(3) If the neutron is not absorbed during the slowing-down process, it eventually reaches thermal energy and ultimately will be absorbed by either uranium or carbon. If uranium and carbon were mixed uniformly, the probability for these two events would be in the ratio of the absorption cross-sections of uranium and carbon for thermal neutrons multiplied by the atomic concentrations of the two elements. Since actually the mixture is not uniform, this is only approximately true. We shall call f the probability that a thermal neutron is absorbed by uranium. In designing a chain-reacting pile one will normally try to adjust things so as to have both f and p as large as possible. Unfortunately, the two requirements are contradictory, because in order to make f large, one shall try to build a system very rich in uranium in order to reduce the probability of absorption of thermal neutrons by carbon. On the other hand, in a system containing a relatively small amount of carbon the slowing-down process will be relatively slow, and consequently the probability of resonance absorption during the slowing down will be large.

It is clear, therefore, that one shall have to conciliate two opposite requirements by finding an optimum value for the ratio of uranium to carbon.

In a homogeneous mixture of uranium and carbon the values of f and p depend only on the relative concentrations of the two elements. If we do not restrict ourselves, however, to homogeneous mixtures only, one can try to obtain a more favorable situation by proper arrangement of the geometrical distribution of the two components. This actually is possible to a considerable extent, because of the following circumstances. The resonance absorption which is responsible for the loss of neutrons during the slowing down has very sharp cross-section maxima of the Breit-Wigner type. Therefore, if the uranium, instead of being spread through the graphite mass, is concentrated in rather sizable lumps, we will expect that the uranium in the interior of a lump will be shielded by a thin surface layer from the action of neutrons with energy close to a resonance maximum. Therefore, the resonance absorption of a uranium atom inside the lump will be much less than it would be for an isolated atom. Of course, self-absorption in a lump reduces not only the resonance absorption but also the thermal absorption of uranium. One can expect theoretically, however, and experiment has confirmed, that at least up to a certain size of lumps the gain obtained by reducing the resonance loss of neutrons overbalances by a considerable amount the loss due to a lesser absorption of thermal neutrons.

The typical structure of a pile is a lattice of uranium lumps embedded in a matrix of graphite. The lattice may be, for example, a cubic lattice of lumps or a lattice of rods of uranium. This latter arrangement is slightly less efficient from the point of view of the neutron absorption balance but often presents some practical advantages, since it makes easier the removal of the heat produced by the pile. In the present discussion we shall consider only lattices of lumps.

It is useful to give some typical figures for the probabilities of the various absorption processes. These probabilities, of course, are not constant but depend on the details of the structure of the lattice. Average figures for a good lattice will be given as an example. When a neutron is first produced by a fission taking place in a lump of uranium, it may have a probability of the order of 3 per cent of being absorbed, giving rise to fission before loosing any appreciable amount of energy. In 97 per cent of the cases when this does not happen the neutron will initiate its slowing-down process, and it may either be absorbed by the resonance process during the slowing down or reach thermal energy. The probability of resonance absorption during the slowing down may be of the order of 10 per cent, so that 87 per cent of the original neutrons will be slowed down to thermal energies. Of these, perhaps 10 per cent may be absorbed by carbon and the remaining 77 per cent by uranium. If we assume for the purpose of example that $\nu = 2$, we shall have in one generation the processes summarized in Table 1. For the example given, the reproduction factor will be, therefore,

$$k = .06 + .77\eta. \tag{3}$$

Consequently, a lattice of the type described would have a reproduction factor larger than 1, provided η is larger than 1.22.

In order to evaluate the reproduction factor one must be able to calculate the probabilities for the various processes mentioned. Some points of view which may be used in the practical calculation will be indicated briefly.

TABLE 1

Probability (%)	Type of process	Neutrons produced per neutron absorbed	Neutrons per generation by one neutron
3	Fast fission	2	.06
10	Resonance absorption	0	0
10	Absorption by carbon	0	0
77	Absorption by uranium at thermal energies	η	.77 η

PROBABILITY OF FISSION BEFORE SLOWING DOWN

The value of this quantity is very easily calculable for a very small lump of uranium. In this case it is obviously given by

$$P_F = \sigma_F nd, \tag{4}$$

where σ_F is the average value of the fission cross-section for fission neutrons; n is the concentration of uranium atoms in the lump; and d is the average value of the distance that the neutron produced in the lump must travel before reaching the surface of the lump. The case of a lump of larger size is more complicated, since then multiple collision processes become important and both elastic and inelastic scattering play a considerable role. In particular, the last process for a lump of large size effectively slows down the neutrons before the fission threshold of U^{238} and brings them down to an energy level in which they are readily absorbed by the resonance process.

RESONANCE ABSORPTION

If we had a single atom of uranium in a graphite medium where fast neutrons are produced and slowed down to thermal energy, the probability per unit time of a resonance absorption process of neutrons with energy larger than thermal energy would be given by the following expression:

$$\frac{q\lambda}{.158}\int \sigma(E)\,\frac{dE}{E}, \tag{5}$$

where q is the number of fast neutrons entering the system per unit time and unit volume, λ is the mean free path, and $\sigma(E)$ is the resonance absorption cross-section at energy E. The integral must be taken between a low limit just above thermal energy and an upper limit equal to the average energy of the fission neutrons. One will expect that the largest contribution to the integral will be due to the Breit-Wigner peaks of $\sigma(E)$.

The above formula would be very much in error in the case of a lattice of lumps. As already indicated, this is due to the fact that inside a lump there is an important self-screening effect that reduces very considerably the density of neutrons having energy close to a resonance maximum.

The best approach to a practical solution to the problem is therefore a direct measurement of the number of neutrons absorbed by resonance in lumps of uranium of various sizes.

Measurements of this type have been performed first at Princeton University, and the results have been summarized in practical formulas that are used in the calculations.

PROBABILITY OF ABSORPTION AT THERMAL ENERGIES

If uranium and carbon were uniformly mixed, a thermal neutron would have a probability

$$\frac{N_U\sigma_U}{N_C\sigma_C + N_U\sigma_U} \tag{6}$$

to be absorbed by uranium. In this formula N_C and N_U represent the numbers of atoms of carbon and of uranium per unit volume, and σ_C and σ_U represent the cross-sections of carbon and of uranium for thermal neutrons.

More complicated is the case of a lattice distribution of lumps of uranium in graphite, since the density of thermal neutrons throughout the system is not uniform but is large at the places far from the uranium lumps and smaller near and inside the uranium lumps, due to the fact that the absorption of thermal neutrons is much greater in uranium than in graphite. Let $\bar{n}_C$ and $\bar{n}_U$ be the average densities of thermal neutrons in the graphite and in the uranium lumps. The number of thermal neutrons absorbed by uranium and by carbon will be proportional to $N_U \sigma_U \overline{n_U}$ and $N_C \sigma_C \overline{n_C}$, and we will have, therefore, instead of Equation (6), the corrected formula,

$$f = \frac{N_U \sigma_U \overline{n_U}}{N_U \sigma_U \overline{n_U} + N_C \sigma_C \overline{n_C}}. \tag{7}$$

For practical purposes it is usually sufficiently accurate to calculate $\overline{n_C}$ and $\overline{n_U}$, using the diffusion theory. The approximation is made to substitute the lattice cell by a spherical cell having volume equal to that of the actual cell, with the boundary condition that the radial derivative of the density of neutrons vanishes at the surface of the sphere. It is also assumed that the number of neutrons that are slowed down to thermal energies per unit time and unit volume is constant throughout the graphite part of the cell. This approximation is fairly correct, provided the dimensions of the cell are not too large. With these assumptions one finds the following formula for the probability, f, that thermal neutrons be absorbed by uranium:

$$f = \frac{3\alpha^2}{\alpha^3 - \beta^3} \cdot \frac{(1-\alpha)(1+\beta)e^{-\beta+\alpha} - (1+\alpha)(1-\beta)e^{\beta-\alpha}}{(\alpha + s - s\alpha)(1+\beta)e^{-\beta+\alpha} - (\alpha + s + s\alpha)e^{\beta-\alpha}} \tag{8}$$

where α and β represent the radius of the lump and the radius of the cell expressed taking the diffusion length in graphite, $l = \sqrt{\lambda\Lambda/3}$, as unit of length. It is further

$$s = \frac{\lambda}{\sqrt{3}} \frac{1+\gamma}{1-\gamma}, \tag{9}$$

where γ is the reflection coefficient of the lump for thermal neutrons.

LATTICE CONTAINING A LARGE NUMBER OF CELLS

The density of neutrons of any given energy in a lattice containing a large number of cells is a function of the position in the lattice. One can arrive at a simple mathematical description of the behavior of such a system by neglecting in first approximation the local variation of such functions due to the periodic structure of the lattice and substituting for the actually inhomogeneous system an equivalent homogeneous system. In this section we shall accordingly simplify the problem by substituting for all densities of neutrons values obtained by averaging the actual values over the volume of the cell. The densities will then be represented by smooth functions such as one would expect in a homogeneous uranium-graphite mixture.

Let $Q(x,y,z)$ be the number of fast neutrons produced per unit time and unit volume at each position in the lattice. These neutrons diffuse through the mass and are slowed down. During this process some of the neutrons are absorbed at resonance. Let $q(x,y,z)$ be the number of neutrons per unit time and unit volume which become thermal at the position x, y, z—q is called the "density of the nascent thermal neutrons."

We shall assume that if an original fast neutron is generated at a point, 0, the probability that it becomes thermal at a given place has a Gaussian distribution around 0. This assumption may be justified by considering that the diffusion process of slowing down consists of very many free paths. Experimentally one finds that the distribution curve of the nascent thermal neutrons around a point source of fast neutrons is represented only approximately by a Gaussian distribution, and formulas have been used in which the actual distribution is described as a superposition of two or three Gaussian curves with different ranges. For the purpose of the present discussion, however, we shall take only one. For each fast neutron produced only p neutrons reach thermal energy. The distribution of nascent thermal neutrons produced by a source of strength 1, placed at the origin of the coordinate, shall then be represented by

$$q_1 = \frac{p}{\pi^{3/2} r_0^3} e^{-r^2/r_0^2}. \tag{10}$$

For graphite of density 1.6 the range, r_0, is of the order of 35 cm. The density of nascent thermal neutrons at point P can be expressed in terms of Q by adding up the contribution of all the infinitesimal sources, $Q(P')d\tau'$ ($d\tau'$ represents the volume element around the point, P'). We obtain in this way

$$q(P) = \frac{p}{\pi^{3/2} r_0^3} \int Q(P') e^{-((P'-P)^2/r_0^2)d\tau'}. \tag{11}$$

The density, $n(x,y,z)$, of the thermal neutrons is connected to q by the differential equation,

$$\frac{\lambda v}{3} \Delta n - \frac{v}{\Lambda} n + q = 0, \tag{12}$$

where λ is the collision mean free path of thermal neutrons, v is their velocity, and Λ is the mean free path for absorption of a thermal neutron. Equation (12) is obtained by expressing a local balancing of all processes whereby the number of thermal neutrons at each place tends to increase or decrease. The first term represents the increase in number of neutrons due to diffusion ($\lambda v/3$ is the diffusion coefficient of thermal neutrons); the second, the loss of neutrons due to absorption; and the third, the effect of the nascent thermal neutrons.

It should be noted that the absorption mean free path Λ in Equation (12) is much shorter than the corresponding quantity, Λ_0, in pure graphite. Indeed, the absorption in a lattice is due mostly to the uranium. In first approximation Λ is given by

$$\Lambda = (1 - f)\Lambda_0. \tag{13}$$

In practical cases Λ may be of the order of magnitude of 300 cm., whereas Λ_0 in graphite without uranium is about 2,500 cm.

When a thermal neutron is absorbed by uranium, η new neutrons are produced by fission. This number should be increased by a few per cent in order to take into account the effect of the small probability of fast fission. Let $\epsilon\eta$ be the total number of fast neutrons so corrected.

The number of thermal neutrons absorbed per unit volume and unit time is $\frac{vn}{\Lambda}$. Of these, the fraction f is absorbed by uranium. We have, therefore,

$$Q = f\eta\epsilon\frac{v}{\Lambda}n + Q_0, \tag{14}$$

where $f\eta\epsilon\,\frac{v}{\Lambda}$ represents the number of fast neutrons produced in the chain reaction process, and Q_0 represents the number of fast neutrons produced by an outside source if one is present. In most cases, of course, Q_0 will be equal to 0. From Equations (11), (12), and (14) we can eliminate all unknowns except n, and we find

$$\begin{aligned} \frac{3}{\lambda\Lambda}n - \Delta n = {} & \frac{3p\,\epsilon\,\eta f}{\pi^{3/2}r_0^3\Lambda\lambda}\int n(P')e^{-(P'-P)^2/r_0^2}\,d\tau' \\ & + \frac{3p}{\pi^{3/2}r_0^3\lambda v}\int Q_0(P')e^{-(P'-P)^2/r_0^2}\,d\tau'. \end{aligned} \tag{15}$$

A solution of this equation is obtained readily by developing both Q_0 and n in a Fourier series. The general term of this development, corresponding to Q_0 of the form $Q_0 \sin\omega_1 x \sin\omega_2 y \sin\omega_3 z$, is:

$$n = \frac{(\Lambda p Q_0/v)\sin\omega_1 x \sin\omega_2 y \sin\omega_3 z}{\left(1 + \frac{\lambda\Lambda}{3}\omega^2\right)e^{\omega^2 r_0^2/4} - \epsilon p f\eta}, \tag{16}$$

where $\omega^2 = \omega_1^2 + \omega_2^2 + \omega_3^2$.

When the dimensions of the pile are finite but very large compared with the mean free path, the boundary condition is that all densities must vanish at the surface. If the pile, for example, is a cube of side a and the origin of the coordinates is taken in one of the corners, it is:

$$\omega_1 = \frac{\pi n_1}{a}; \quad \omega_2 = \frac{\pi n_2}{a}; \quad \omega_3 = \frac{\pi n_3}{a}, \tag{17}$$

where n_1, n_2, n_3 are positive integral numbers that define the various Fourier components. The critical dimensions of the system are such that the denominator of Equation (16) vanishes for the 1,1,1 harmonic, since in this case the density of the neutrons becomes infinitely large. The critical condition can be expressed, therefore, by the equation:

$$\left(1 + \frac{3\pi^2}{a^2}\frac{\lambda\Lambda}{3}\right)e^{3\pi^2/a^2 r_0^2/4} = \epsilon p f\eta \tag{18}$$

The right-hand side in this formula is the reproduction factor, k, for a system of infinite size. We can therefore write the critical condition as follows:

$$k = \left(1 + \frac{3\pi^2}{a^2}\frac{\lambda\Lambda}{3}\right)e^{3\pi^2/a^2 r_0^2/4}. \tag{19}$$

In most cases both the exponent of e and the term added to 1 in the parentheses are small compared with 1, and so the previous expression can be simplified to:

$$k = 1 + \frac{3\pi^2}{a^2}\left(\frac{\lambda\Lambda}{3} + \frac{r_0^2}{4}\right). \tag{20}$$

This formula can be used in order to calculate the critical side of a pile of cubical shape. If, for example, we assume for a special lattice numerical values of $\lambda = 2.6$ cm., $\Lambda = 350$ cm., $r_0^2 = 1{,}200$ cm.^{2}, and $k = 1.06$, we find for the critical side of a cubical pile, $a = 584$ cm. Naturally, these constants are merely hypothetical, and though included within the possible range, are in practical cases strongly dependent on the details of the lattice structure.

It is useful to derive an approximate relationship between the power produced by a pile and the intensity of thermal neutrons inside it. Roughly 50 per cent of the thermal neutrons absorbed in a pile give rise to fission, and the energy released per fission is of the order of 200 MEV. This corresponds to about 1.6×10^{-4} ergs per thermal neutron absorbed. Since the number of thermal neutrons absorbed per unit volume is vn/Λ, the energy produced is approximately

$$\frac{vn}{\Lambda}1.6 \times 10^{-4} \cong 4.6 \times 10^{-7}\,vn \text{ ergs/cm.}^3\text{ sec.} \tag{21}$$

Naturally, the power is not produced uniformly throughout the pile because n is a maximum at the center and decreases to 0 at the edge of the pile. For a cubical pile n is represented approximately by

$$n = n_0 \sin\frac{\pi x}{a}\sin\frac{\pi y}{a}\sin\frac{\pi z}{a}, \tag{22}$$

where n_0 is the density of neutrons at the center of the pile. Integrating the previous expression (21) over all the volume of the pile, one obtains the following formula for the power:

$$W = \frac{8}{\pi^3}4.6 \times 10^{-7}\,nv\,a^3 = 1.2 \times 10^{-7}\,n_0 v\,a^3. \tag{23}$$

If, again, we take as an example a pile with a side of 584 cm., we find $W = 24 n_0 v$ ergs/sec. When the pile is operating at a power of 1 kw., the flux of thermal neutrons at the center is therefore about $n_0v = 4 \times 10^8$ neutrons/cm.^{2} sec.

DESCRIPTION OF A GRAPHITE PILE AT ARGONNE LABORATORY

The first pile was erected under the West Stands on the campus of the University of Chicago at the end of 1942. After having been operated there for a few months it was moved to the Argonne Laboratory, near Chicago, where it has been used until now for various research purposes.

The lattice of that pile is not the same throughout the structure. Since only a small amount of uranium metal was available at that time, metal has been used in the central portion of the pile and uranium oxide in the outer portion.

The intensity of operation of the pile is recorded by a number of BF_3 ionization chambers connected to amplifiers or to galvanometers.

Since this pile has no cooling devices built into it, the power produced is limited by the necessity of avoiding an excessive temperature rise. The pile could be operated indefinitely at a power of 2 kw. and is often operated for periods of the order of one or two hours up to about 100 kw.

One feature that is often used for neutron research work is the thermal column, a column of graphite having sides of about 5 x 5 feet, which is built on the center of the top of the pile and goes through the top shield. The neutrons that diffuse from the pile into this column are rapidly reduced to thermal energy so that the neutrons inside the column a few feet above the top of the pile are practically pure thermal neutrons.

The pile is also equipped with a number of holes in the shield and removable stringers of graphite that make it possible to explore phenomena inside the pile or to introduce samples for neutron irradiation.

When the pile is operated at 100 kw., the flux of thermal neutrons at the center is about 4×10^{10} neutrons/cm.^{2} sec.

Work With Residual DDT Spray in Puerto Rico:

A Report of the First Year's Work

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U. S. Public Health Service, Atlanta, Georgia

IN THE FALL OF 1944, the U. S. Public Health Service, in cooperation with the Insular Health Department and the School of Tropical Medicine, inaugurated a residual DDT spray project to determine whether this new method of malaria control which has been so remarkably successful in other parts of the world might be of practical value in Puerto Rico, where the important vector (*Anopheles albimanus*) is a "wild" mosquito which feeds on humans during twilight or at night and seldom remains inside houses for more than a few hours. The results of the first year's work are presented herein.[1]

Two villages approximately 30 miles apart and rather similar in size, population, racial composition, occupation of inhabitants, house construction, rainfall, general ecology, relation to vector-breeding areas, proximity to ocean, relation to rivers, isolation, and mosquito populations were selected for the experiment. Humacao Playa, on the east coast, was chosen as the test village to be sprayed with DDT, while Loiza Aldea, on the northeast coast, was used as an untreated check village.

In each village *A. albimanus* indices were obtained by animal-bait and light trap collections throughout the year. The only previous, long-range malaria control experiment in Puerto Rico was conducted at Salinas during the period 1930–36 and has been reported by Earle (*1*). His data show that in this small, unscreened native village little reduction in number of malaria cases occurred until the *albimanus* population had been reduced to such a low level that animal-bait traps collected less than one *albimanus* per night. In the villages used in the present experiment, bait and light traps caught from one to several hundred *albimanus* on most nights when traps were operated. It is therefore believed that *albimanus* was present in sufficient numbers to transmit malaria throughout the study period.

Unlike the DDT residual spray work with *A. quadrimaculatus* at Stuttgart, Arkansas, and with *A. pseudo-*

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[1] The studies on which this report are based were conducted jointly by personnel of the U. S. Public Health Service District #6, Communicable Disease Center activities; the Bureau of Malaria Control, Puerto Rico Department of Public Health; and the School of Tropical Medicine, San Juan, Puerto Rico. The writers wish to acknowledge the assistance and cooperation of officials of the Communicable Disease Center, Atlanta, Georgia; Carter Memorial Laboratory, Savannah, Georgia; Office of Malaria Investigations, National Institute of Health; and District #6, U. S. Public Health Service. The commissioner, Insular Health Department, and the director of the School of Tropical Medicine also have given valuable advice and assistance. Army officials at Fort Bundy generously provided a number of buildings for experimental use.

punctipennis in Mexico, reported by Stage (*2*), no reduction in numbers of *A. albimanus* was found at either Puerto Rican town. In fact, collections of *A. albimanus* at Humacao Playa were actually larger in October and November 1945 than those made in October and November 1944 from identical bait and light traps in the same locations, even though the village had been treated with residual DDT spraying twice between November 1944 and October 1945.

Normally, in Puerto Rico the peak incidence of *A. albimanus* is reached in the fall and winter months from September through December or January, depending on the distribution of rainfall during this period, which constitutes the "rainy season." In most areas where malaria surveys have been conducted over a period of years it has been found that the greatest number of malaria cases occur during this same period, usually lagging a month or two behind the peak in *albimanus* population. Then there follows a marked reduction in the number of malarial mosquitoes and a gradual decline in number of cases of malaria during the period from January to, or through, April, which constitutes the "dry season." Depending upon the beginning of the "rainy season," malarial mosquito production and number of malaria cases begin increasing in late April or early May and continue at an accelerated rate until the period October to January, when the "dry season" begins again.

TABLE 1

COMPARISON OF MALARIA RATES IN UNTREATED AND TREATED VILLAGES IN PUERTO RICO

Date	Total number of positive films of:				Total films			Positive films (%)
	P. falciparum	*P. vivax*	*P. malariae*	*P.* undeterm.	Positive	Negative	All	
(Untreated Village—Loiza Aldea)								
First survey November 1–15, 1944	26	30	1	3	60	1,210	1,270	4.7
Second survey March 19–April 5, 1945	7	6	0	0	13	830	843	1.5
Third survey November 1–15, 1945	13	20	0	0	33	835	868	3.8
(Treated Village—Humacao Playa)								
First survey October 15–31, 1944	47	33	2	3	85	1,384	1,469	5.8
First residual DDT spraying November 1–17, 1944								
Second survey March 5–14, 1945	9	19	1	5	34	1,177	1,211	2.8
Second residual DDT spraying June 15–29, 1945								
Third survey October 15–31, 1945	5	4	1	0	10	1,083	1,093	0.91

During the course of this study, three blood film surveys were made: the first, in October and November 1944; the second, in March and April 1945; and the third, in October and November 1945. The slides were stained within 24 hours of the time of collection, and later sent to the Memphis or Atlanta laboratories of the U. S. Public Health Service for examination by trained technicians. The results are given in Table 1.

It will be seen from examination of Table 1 that the percentage of positive malaria slides from the untreated check village of Loiza Aldea followed approximately the normal cycle for Puerto Rico, with 4.7 per cent positive during the "rainy season" of November 1944, a decrease to 1.5 per cent positive during the "dry season" of March–April 1945, and a marked increase to 3.8 per cent positive during the "rainy season" of November 1945. On the other hand, in the village of Humacao Playa, which was sprayed with DDT twice during the period November 1944 to October 1945, there was a progressive decline in percentage of positive malaria slides: from 5.8 per cent in the "rainy season" of October 1944 to 2.8 per cent in the "dry season" of March 1945; and most significantly of all, to 0.91 per cent during the "rainy season" of October 1945.

It is believed that these data, which show a marked reduction in malaria in the DDT-treated village, indicate that DDT may be an effective weapon against malaria in the areas where the vector mosquito is of the "wild" variety, such as *A. albimanus*. Further experience will be necessary before its effectiveness under other conditions and against species with similar habits can be evaluated.

Details of DDT residual spray procedure will be discussed in a subsequent paper. However, it may be stated that approximately 500 houses with adjacent outbuildings were treated three times during the first year: the first residual spraying in November 1944, with an over-all average of 309 mg. of DDT per square foot, at a cost of $1.31 per house; the second, in June 1945, with an average of 147 mg. per square foot, at a cost of $.98 per house; and the third, in June 1945, with an average of 190 mg. per square foot, at a cost of $.98 per house.

Puerto Rican families average about five persons each. Thus, the per capita cost was between $.20 and $.26 for a single application of DDT in Humacao Playa, or between $.60 and $.80 a year. This is not an exorbitant figure when it is realized that, in addition to reducing malaria, residual DDT spraying may play an important part in preventing the transmission of other insect-borne diseases of the Island, such as filariasis and dengue, and other diseases such as typhoid fever, diarrhea, and dysentery in which flies may play a vector role. Moreover, residual DDT spraying is effective in controlling such common household pests as bedbugs and cockroaches for several weeks or months.

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Research or Available Knowledge:

A Matter of Classification

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THE SCIENTIFIC DEVELOPMENTS of the past five years are fabulous by previous standards. Some are widely known. Radar and the atomic bomb, for example, have become household words. Many of the less spectacular developments are no less important, even though known and understood only by those few people who have taken part in their evolution and application to practical purposes. Impressive and vast as are the projects in which these accomplishments have been made, they actually consist of countless thousands of individual details of scientific progress. In the majority of cases these details have been worked out as a result of long and painstaking efforts and a great deal of "research."

The term "research" has gained the respect and even the awe of our people because they are shown results on an impressive scale flowing out of large-scale efforts described as "research." But the condition of the sources of information which must be searched by research workers is chaotic indeed. Two and a half million different U. S. Patents stand as one example of the number of items that can be involved in dealing with technical information, not to mention the many additional millions of foreign patents. Scientific papers and dissertations in this and other countries add a formidable number of possible sources of detailed information and guidance. As long ago as 1933, S. C. Bradford, of the Science Museum Library in London, estimated that 750,000 scientific and technical papers were published annually in 14,000 different periodicals. More recent estimates indicate that the rate has doubled since then.

In the early days of science, when it was much less complex and confusing, philosophers discoursed on how it grew. Progress, they discovered, came most effectively when that which was already known was fully organized and sorted out. Generalities on which future advances could be based were made only by a careful analysis of the pattern formed by that which was already known. This was obvious to Aristotle 2,300 years ago and was expounded in his *Posterior analytics*. Today science has acquired so many facets, so many millions of possible channels of development, that it is far more difficult to organize into a coherent pattern. Our libraries, universities, research laboratories, learned societies, and industrial organizations all struggle in futile fashion with their individual segments of the problem.

The obvious need is for the coordination and standardization of the system by which all such material is sorted and classified, so that all who may be interested can at least direct their attention to a certain small portion of the whole mass of published material, selected in terms which are defined alike for all. Some organization, either public or private, must accept the burden of taking the infinite pains necessary to see that all scientific subject matter is classified according to logical principles, on a standardized basis acceptable to all who need it, whether for future scientific development or for the application of that development to industrial production.

Libraries classify their books and periodicals according to a number of systems, two of which are the most widely recognized. In this country many libraries follow a system established by the Library of Congress, using an arbitrary combination of letters and numerals. Many others, both here and abroad, follow a generally standard decimal system. This latter has great possibilities in providing a precise diagnosis, especially when the number of decimal places used grows to 12 or 15 digits. Unfortunately, much of the expansion has been made by people whose interest was in sorting and finding material for strictly literary purposes.

The Patent Office, faced with a growing mountain of patents to be issued, has been forced to make some progress toward a universal classification system as applied to technical subjects. The millions of patents are now grouped in some 300 main classes, which are further divided into over 40,000 specific subclasses. Each subclass contains a particular field of inventions, with an explicit definition. This definition is carefully worked out to indicate material excluded from the particular subclass defined, with guiding search notes to help find such material. Obviously, the subclasses themselves are grouped to facilitate the selection of the minimum field of search necessary to assure finding the particular subject matter required. Necessity has also brought into existence in the Patent Office a small staff of experienced workers constantly studying the need for additional subdivisions or arrangements to provide for growing arts.

The system used in the classification of patents has been dictated by the needs of those who must use it constantly in their work, in examining patent applications for novelty and in making searches to determine whether a given patent is completely valid and infringed by the manufacture or sale of some device or the use of a certain process. The controlling factor in classifying patents must be the most *generic or essential function* of the device classified. An internal combustion engine, for example, is a device for producing power, whether that power drives an automobile or pumps water. Classifying the engine under automobile engines would effectively lose it for anyone seeking the details of an exactly similar engine which he had conceived as part of a system for pumping water.

In patent searching it is necessary to be certain that the search can be absolutely complete after looking at as few disclosures as possible. One patent erroneously classified and not located may turn up later and destroy a business founded on the studied belief that no patent was infringed or that the patents on which it was founded were completely new and valid. Yet there is a practical limit to the searching possible to determine those facts. However detailed a library type of classification may become, it is not concerned with the problem of limiting the number of items placed in a given subclass.

Many large corporations have collected the few thousands of patents in fields of special importance to them and have then sorted them still further according to systems which happen to meet their particular requirements. In some cases the same system is then used to some extent to sort and classify collections of published articles and other available material in the selected field, and frequently is used as a guide to research programs. The problem of handling published material faces all organizations engaged in scientific and technical research. There are countless librarians and clerks in research laboratories all over the country, patiently making card files and cross-indexes of journal articles and other material that has been found useful or for which a future need is anticipated. Some few of these collections have been further organized to permit the use of mechanical devices such, for example, as punch-card collections and sorting machines to select cards that may represent precise groups of patents or published articles pertaining to a particularly defined problem.

There are machines now available which can select such things as cards or films according to codifications of an almost infinite number of subdivisions. The card or film may also carry microfilm or microprint reproductions of the material it classifies. The interest in this type of equipment was illustrated recently during the symposium of the American Chemical Society at Chicago. A day was devoted to the discussion of the use of such mechanical contrivances for preparing bibliographies on chemical subjects. The scientists attending were so absorbed in the possibilities presented that the normal day session was carried on well into the night. In conjunction with some of the large chemical companies the American Chemical Society is continuing to pursue this attractive project.

It seems a pity that such interest and effort cannot be organized to develop and maintain a single standard system whereby many can benefit from the accomplishments of the various individual efforts now isolated in their own narrow activities. The infinitude of detail which can be studied and arranged by particular organizations dealing with a small section of scientific thought might well benefit all who worked in that field if it were collected in a central agency and coordinated with similar work done by hundreds of similar organizations working in their own particular fields. This system need not be limited to a single type of arrangement for a given subject. There may be alternative classification schedules for a given subject matter to serve different users. With modern equipment these may be solved as simultaneous equations to find, for example, a specific structure used for a particular purpose.

If we carry our dreaming far into the remote future, it is possible to imagine a National Library of Science, patterned after the present Library of the Department of Agriculture, with facilities organized on a scale to embrace all of the fields of scientific and technical effort. With truly modern methods of sorting and filing material, using machines and microphotography, any item of scientific knowledge could be selected almost immediately and furnished to some worker in a position to carry it on to some additional purpose, at a very nominal cost if done on a sufficiently large scale.

The Department of Agriculture Library has already established a very high reputation for service in its field. Any research worker in agricultural subjects is able to obtain very quickly photostatic or microfilm reproductions of practically any published article desired. Specially trained experts are on hand to prepare bibliographies on selected topics for the Department or for other government agencies. Every effort is made to have this type of information readily available.

It is logical to consider such facilities as the Search Room of the Patent Office, for example, as a nucleus of such an ultimate Library of Science. It has a great store of disclosures of inventions which are dedicated to the free use of the public after a few years of exclusive control by the inventor. A system of classification such as is used in the Patent Office, integrated perhaps with the Universal Decimal System, could serve as a basic framework on which to build a really effective system of technical and scientific classification. Such a system would justify a corps of specialists continually supervising its development in accordance with the needs of scientific and technical workers using it. A council of recognized leaders in the major fields of science and technology should meet at periodical intervals to study proposed revisions and guide the efforts of the staff to maintain the system effective and acceptable to all concerned.

Once a system is accepted as standard, the actual labeling of the material with its class and subclass numbers can be done, in many cases, at the source. Magazines and journals, for example, could readily indicate this information with each article, just as the present-day manufacturer of bolts and nuts can indicate on the label pasted on a container the size and number of threads on these useful devices, according to a standard system. Until such complete acceptance is reached, the libraries and technical societies and organizations can gradually make more and more widespread use of the system in steadily progressive stages.

Such devices as the punched card make it possible to correlate a number of systems of classification, so that a user familiar with any one system may be guided into a mass of information organized according to another system. Over a period of time, the ineffective systems would clearly display their weakness and fall into disuse. Thus, it is unnecessary to contemplate the obviously impossible sudden shift from present systems, representing the accumulated efforts of many years, to a new and different system.

Once we all learn that there are certain effective principles which are most successful in organizing and relating information, and that there are guides and mechanical aids to conduct us from our familiar paths into those chosen by others, much of the bitter controversy as to the respective merits of various systems should disappear. Every creative worker in scientific fields will become a contributor to the development of the eventual standard or truly universal system. When that system is accepted and maintained, time now spent in uncertain hunting for clues to likely sources of information will be substantially eliminated.

Obituary

Leo Černosvitov

1902–1945

Although the common earthworm is one of the most widely investigated of laboratory animals, the number of competent students of oligochaete taxonomy has always been very limited. Perhaps this is due to the intrinsic difficulty of the subject, since the description of each new species is in itself almost an anatomical memoir. Leo Černosvitov, whose untimely death has deprived the scientific world of one of its most promising oligochaetologists, possessed the special qualifications so essential for an investigator in this field of knowledge. He received a thorough training in zoology at the University of Prague, where the subject of his Doctor's dissertation (1927), "La régression physiologique des organes génitaux du *Tubifex tubifex*," prepared him for both biological and taxonomic investigations.

His career was a stormy one, but filled with interest and adventure. Born at Poltava, Russia, in 1902, he fought with the White Army and was later evacuated, as a boy of 17, to Constantinople. In 1921 he went to Prague and received his higher education under the auspices of the Czech Government. After graduation he began an intensive study of the Oligochaeta which culminated in the publication of some 55 papers in this field alone. A survey of the *Zoological Record* shows that he described, in his short and much interrupted career, some 86 new species, exclusive of redescriptions and assignations of new names. His work on oligochaetes was not confined to a limited group or to a restricted geographical region, but, at one time or another, he studied representatives of nearly every family and from many different parts of the world. Among his more important contributions are a long series of articles dealing with the oligochaete fauna of the Balkan countries, that hotbed of zoological endemicity; a systematic revision of the *Enchytraeidae*, as well as numerous shorter papers on this, the most difficult of oligochaete families; and a review of the literature on cavernicolous oligochaetes. He was the first to observe uniparental reproduction in oligochaetes, and his studies on the resorption of spermatozoa are of equally general interest and importance.

In addition to his work on oligochaetes, Černosvitov engaged in many other activities, earning his living in a variety of ways, as lecturer, as entomologist, and as research technician in the Dental Clinic of the University of Prague. As entomologist he visited the Argentine in 1931–32 to study the control of insect pests in the plantations, and as a result of this visit he published several papers on South American oligochaetes. He investigated spruce sawfly for the British Imperial Institute of Entomology and was in Finland, engaged in this work, at the outbreak of the war. Returning to London, he became monitor for the BBC, feeling this to be his most useful service as a refugee alien, on account of his exceptional knowledge of foreign languages.

At the time of his sudden death from a heart attack, on December 15, 1945, he was on the threshold of happiness and security. Four days previously he had been appointed to the staff of the British Museum, and at last it had seemed that he could devote his entire energies to the work that he loved best. It is to be hoped that arrangements can be made for the completion of his unfinished Monograph of the British Oligochaeta, if not for his projected review of the economic importance of earthworms.

GRACE E. PICKFORD

Bingham Oceanographic Laboratory and
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NEWS *and Notes*

President Truman on December 31 signed an executive order transferring control of the U. S. atomic energy program from military to civilian hands. The action followed immediately after appointment of Carroll L. Wilson, formerly executive assistant to Vannevar Bush, director of OSRD, as general manager of the Atomic Energy Commission, upon unanimous recommendation to the President by Commission members.

Two other events occurred when the Commission and its General Advisory Committee of Scientists met in Washington during the first week of the new year: 1) J. Robert Oppenheimer, professor of physics, University of California, and wartime director of the Los Alamos, New Mexico, laboratory, was elected chairman of the General Advisory Committee; 2) three labor consultants were appointed by the Commission as part of a program "to insure the soundest possible labor-management relationships."

The labor group included George H. Taylor, professor of industrial relations, Wharton School of Finance and Commerce, University of Pennsylvania, and former chairman of the War Labor Board; Lloyd K. Garrison, New York attorney, former general counsel and chairman of the War Labor Board and until recently dean of the School of Law, University of Wisconsin; and David A. Morse, Assistant Secretary of Labor and former general counsel of the National Labor Relations Board.

The Commission is making plans to assume control of the Manhattan Engineer District, an operation involving about 43,000 employees, and its consultants have already made a preliminary study of industrial relations at the major atomic energy installations.

Mr. Wilson has served as a consultant for the Atomic Energy Commission since its appointment in October. Prior to this and since the end of the war Mr. Wilson was secretary of the State Department Board of Consultants on International Control of Atomic Energy under the chairmanship of David E. Lilienthal, who is also chairman of the Atomic Energy Commission. Other members of the Board with whom he worked were Chester I. Barnard, president, New Jersey Bell Telephone Company; J. Robert Oppenheimer; Charles Allen Thomas, vice-president, Monsanto Chemical Company; and Harry A. Winne, vice-president, General Electric Company.

Mr. Wilson became executive assistant to Dr. Bush as director of OSRD at the time of its organization after similar work with the National Defense Research Committee and served until the end of the war. He was active in setting up the entire organization, was responsible for coordinating the various branches of OSRD, and directly supervised the Office of Scientific Personnel.

On December 12 President Truman appointed a nine-man General Advisory Committee made up of James Bryant Conant, president of Harvard University and president of AAAS; Lee A. DuBridge, president, California Institute of Technology; Enrico Fermi, professor of physics, University of Chicago; I. I. Rabi, professor of physics, Columbia University; J. R. Oppenheimer, professor of theoretical physics, University of California; Glenn T. Seaborg, professor of chemistry, University of California; C. S. Smith, director, Institute of Metals, University of Chicago; Hartley Rowe, vice-president, United Fruit Company; and Hood Worthington, chemical engineer, E. I. du Pont de Nemours & Co. (*Science*, December 13 and 20).

The $1,000 prize awarded by AAAS each year for an outstanding contribution to science presented at the annual winter meeting was divided this year between two research teams.

One-half went to T. M. Sonneborn, Winifred Jacobson, and Ruth V. Dippell, of Indiana University, for their studies on the mechanism of heredity of paramecium.

The other half was awarded to Quentin M. Geiman and Ralph W. McKee, Harvard University, for their method of growing malaria *in vitro*. The latter study began in July 1943, and continued until December 1945, under the direction of Eric G. Ball, of Harvard, and was later continued by the prizewinners under a grant-in-aid from the U. S. Public Health Service. By December 1946, a method was developed for keeping the malaria parasite alive in test tubes for as long as seven days. Dr. Geiman acknowledged his debt to predecessors on whose work his own was based, particularly that of William Trager, Rockefeller Institute of Medical Research, who in 1941 succeeded in culturing avian malaria.

The Indiana geneticists brought the second recognition to that institution within the past few weeks. H. J. Muller received the Nobel Prize on December 10 for his studies on the influence of X-rays on genes and chromosomes. In 1927, when he was at the University of Texas, this work was awarded the $1,000 AAAS prize. Dr. Muller, who had flown to Stockholm to receive the prize from King Gustav, returned to the United States on December 22 and attended the meetings in Boston.

In 1936 W. M. Stanley, who shared the Nobel Prize in chemistry this year, won the AAAS award for his biochemical investigation of tobacco mosaic virus proteins.

In 1939, I. I. Rabi, Department of Physics, Columbia University, presented the winning paper on "Radio Frequency Spectra of Atoms and Molecules."

In 1941, the last time at which an annual prize was given at an Association meeting, the award was also divided between three people: Dugald E. S. Brown and Douglas A. Marsland, of New York University, for their paper on "The Reversible Denaturation of Enzymes as a Determining Factor in the Reactions of Biological Systems to Temperature and Pressure" and Frank H. Johnson, of Princeton University, for his closely related paper on "The Mechanism of Temperature and Hydrostatic Pressure Reversal of Narcosis in Luminous Bacteria."

The Association now grants three $1,000 prizes. Announcement was made in Boston (*Science*, December 27) of a new $1,000 prize for magazine writers of popular scientific articles; and, as announced previously (*Science*, December 13), the $1,000 AAAS-George Westinghouse Science Writing Award for newspaper reporting in 1946 was won by James Graham Chesnutt, of the San Francisco *Call-Bulletin*.

About People

Glenn T. Seaborg, professor of chemistry, University of California, and co-discoverer of plutonium, americium, and curium, was recently selected "Chemist of the Year" in a national poll of chemists and chemical engineers conducted by the American Chemical Society. Prof. Seaborg, a member of the nine-man advisory committee to assist the United States Atomic Energy Commission, during the war directed research on plutonium and other transuranium elements at the University of Chicago Metallurgical Laboratory (*Science*, October 25).

Charles H. Swift, associate professor and secretary of the Department of Anatomy at the University of Chicago, has retired with emeritus status. Dr. Swift has been associated with the University for the past 47 years.

Robert F. Rinehart has been promoted to professor of mathematics at Case School of Applied Science. Dr. Rinehart has been a member of the Case faculty since 1937. On May 31 he was awarded the Medal for Merit in recognition of his wartime activities with the Operations Research Group of the Navy.

Bascom A. Belcher, formerly a major in the U. S. Army, has been appointed associate agronomist in the Division of Sugar Plant Investigations. U. S. Department of Agriculture, and will be locally in charge of the U. S. Sugar Plant Field Station located at Canal Point, Florida. Mr. Belcher served 11 months as an agricultural economist with Natural Resources Section, GHQ, SCAP, in Tokyo, Japan. At the Canal Point Station, he will carry forward research work associated with sugarcane breeding and sugarcane agronomy.

Joseph E. Greaves, head of the Department of Bacteriology and Biochemistry and on the faculty of the Utah State Agricultural College since 1907, retired from administrative duties on June 30. He continues on the teaching faculty.

C. O. Miller, since 1938 vice-president and scientific director, Lakeside Laboratories, Milwaukee, Wisconsin, has been named president of the Kremers-Urban Company, Milwaukee.

P. H. Waring Webb, formerly at the University of North Carolina, has been appointed associate professor of biology at Coker College, Hartsville, South Carolina.

Edgar Compere, formerly of the Standard Oil Company of New Jersey, Louisiana Division, has been appointed assistant professor in the Department of Chemistry, Louisiana State University.

Edward J. Van Loon was appointed to the staff of the Department of Biochemistry, School of Medicine, University of Louisville, Kentucky, September 1. Since January 1946 he had been an instructor in biochemistry at Michigan State College.

Merrill F. Roff, formerly director of the Aviation Psychology Program, Office of the Air Surgeon, AAF, has joined the staff of the Research Division, Air University School of Aviation Medicine, Randolph Field, Texas, as chief of the Department of Psychology.

Donald P. Costello, professor of zoology, University of North Carolina, has become a member of the Editorial Board of the Biological Bulletin, Marine Biological Laboratory, Woods Hole, Massachusetts.

William T. Winne, formerly at Cornell University, has been appointed assistant professor of botany, Union College, Schenectady.

Stephen F. Roach has been appointed instructor in physics at the Jersey City Junior College.

Grants and Awards

Vannevar Bush, president of the Carnegie Institution of Washington, and director OSRD, has been named 1946 winner of the Hoover Medal, awarded jointly by the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers. Dr. Bush will receive the award January 30 in New York City at the winter meeting of the latter society.

The citation refers to Dr. Bush as an "engineer, educator, and administrator, who, in critical time of need, was in a most special sense an organizer, guiding spirit, and driving force of the nation's achievements in physical and medical science."

The first medal was conferred in 1930 upon Herbert Hoover, for whom the award is named. Dr. Bush is the ninth recipient.

In addition to this award, Dr. Bush holds the Holley Medal of the American Society of Mechanical Engineers and the Edison Medal of the American Institute of Electrical Engineers.

Certificates of Exceptional Service for their "personal contribution" in producing the binocular developed by Bausch & Lomb at the request of the Navy Department have been presented to three employees—J. Donald Dutcher, Henry F. Kurtz, and Willard T. Perkins—who are principally responsible for designing an accurate gunfire control instrument, the submarine telescope, Mark 91.

The American Academy of Arts and Sciences, under terms of a gift of the late Francis Amory, Beverly, Massachusetts, will offer a substantial prize for outstanding work on alleviation or cure of diseases affecting human reproductive organs. The gift provided a fund, the income of which may be awarded at seven-year intervals as a prize and medal to any individual or individuals for work of exceptional merit in this field. If work warranting it has appeared, the next award will be made in 1947 for the most outstanding contribution, as based on published work and recognized accomplishment, in the past seven years. Suggestions aiding the Committee in making a selection may be addressed to Secretary Amory Fund Committee, American Academy of Arts and Sciences, 28 Newbury Street, Boston, Mass.

A Lasker Group Award was presented to the Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture, "in recognition of distinguished service in the solution of problems involving the health and comfort of the armed forces, with particular reference to insect-borne diseases," by the American Public Health Association, at the 1946 convention of public health workers November 12 in Cleveland, Ohio. F. C Bishop, assistant chief in charge of research at the Bureau, and over-all director of research conducted for benefit of the armed forces, received the award for the Bureau.

Colleges and Universities

Lehigh University has received a grant of $60,000 from the War Department to make an engineering analysis of bomb damage reports and studies made in World War II.

The United States Naval Academy will hold examinations for positions in the civilian faculty April 4 and 5. Starting salary for science instructors is $4149.60, for assistant professors $4400.40, and for associate professors $4902.00. Application forms and notice of requirements may be obtained from the Superintendent, United States Naval Academy, Annapolis, Maryland. Applications must be submitted before March 15, 1947.

A War Memorial Scholarship of $1,000 in Mechanical Engineering has been established at Ohio State University by Dr. and Mrs. William Lloyd Evans in memory of their son, William Arthur, a graduate of Ohio State's Department of Mechanical Engineering, lost in action in enemy waters while serving as radar and communications officer aboard the submarine *U.S.S. Tullibee*. Dr. Evans was for many years chairman of the University's Department of Chemistry

St. Louis University School of Medicine has announced the following recent faculty changes: Percy J. Carroll, Brig. Gen. U. S. Army (ret.), assistant dean and professor of public health; Mark C. Wheelock, University of Alabama, assistant professor of pathology; Paul Murphy, Washington University, assistant professor of clinical medicine; and Benjamin DeBoer, University of Missouri, assistant professor of pharmacology.

The Department of Pharmacology, University of Chicago, is continuing work on the cinchona alkaloids under the direction of E. M. K. Geiling and F. E. Kelsey, under a grant made by Cinchona Products Institute of New York.

The University of Rochester is preparing for a nationwide competition among high school students for five science scholarships valued at $1,500 each. Fourth annual competition of its type, the contest was inaugurated by the Bausch & Lomb Optical Company, and is open to students in the more than 4,500 high schools and preparatory schools participating in the Bausch & Lomb Honorary Science Awards. Under the latter program, established in 1932 to encourage young people to engage in scientific careers, medals are presented each year to graduating seniors having highest standings in scientific subjects.

Winners of the fourth annual science scholarship contest will be chosen by the University Scholarship Committee next spring from students who received medals during their four years of high school.

Fifteen boys and girls have won $1,500 scholarships in the past three years. Eleven others stood so high that they were given other university scholarships for nearly equivalent amounts.

Wayne University College of Medicine has been awarded a grant of $10,000 by the U. S. Public Health Service in support of research on the pharmacology of synaptic function. The project will be carried on in the Department of Pharmacology and Therapeutics under the direction of Amedeo S. Marrazzi, head of the department.

Bowdoin College has recently received three gifts from psychologists: a set of lithoprints of great philosophers and psychologists, donated by Linus W. Kline; and the libraries of the late Charles T. Burnett (formerly professor of psychology at the College) and of the late Edwin B. Holt.

A national survey of the requirement and availability of botanists, prepared at the request of President N. E. Stevens, of the Botanical Society of America, has been completed. The study shows that by 1950, on a conservative estimate, there will be a shortage of 277 botanists with the Ph.D. and 177 with the Master's degree. This is 32 per cent and 46 per cent short of the 1950 anticipated requirements. Copies of the survey, furnished without charge to any who may be interested, may be obtained by writing to: Dr. K. Starr Chester, Department of Botany and Plant Pathology, Oklahoma A. & M. College, Stillwater.

Elections

Charles A. Thomas became president-elect of the American Chemical Society for 1947, according to an announcement from the Council. Dr. Thomas is vice-president and technical director of the Monsanto Chemical Company, St. Louis, and project director of the Clinton Laboratories at Oak Ridge, Tennessee. He was one of the co-authors of the Acheson-Lilienthal report on international control of nuclear power. (See *Science* April 12, 1946.)

The Council also announced the election of four new councilors-at-large for three-year terms: Cecil L. Brown, director of the Esso Laboratories, Standard Oil Company of Louisiana, Baton Rouge; M. L. Crossley, research director, American Cyanamid Company, Bound Brook, N. J.; Glenn T. Seaborg, University of California, Berkeley; and Roger J. Williams, director, Biochemical Institute, University of Texas.

Roger Adams, a member of the new Publications Committee of AAAS is chairman of the Chemical Society's Board of Directors.

The Royal Society, London, at its anniversary meeting November 30, elected Sir Robert Robinson president, Sir Thomas Merton treasurer, Sir Alfred Egerton and Sir Edward Salisbury secretaries, and E. D. Adrian foreign secretary. Other members of the Council include: C. H. Andrewes, W. T. Astbury, W. Brown, E. C. Bullard, A. C. Chibnall, C. A. Lovatt Evans, N. H. Fairley, R. A. Fisher, S. Goldstein, E. L. Hirst, H. W. Melville, M. H. A. Newman, M. L. E. Oliphant, C. F. A. Pantin, H. H. Read, and Sir Reginald Stradling.

Edward B. Tuohy, associate professor of anesthesiology, Mayo Clinic and Mayo Foundation, was elected president of the American Society of Anesthesiologists, Inc., for 1947 at a meeting in New York City December 12.

Meetings

The 8th International Congress of Genetics will be held in Stockholm in the summer of 1948. Swedish geneticists have formed an Organization Committee for the Congress, with Gunnar Dahlberg, University of Uppsala, chairman, and Gert Bonnier, Institutet för Husdjursförädling, Wiad, Eldtomta, general secretary.

Recent Deaths

Frank Clifford Stockwell, 63, Stevens Institute, died at his home in Hoboken, N. J., December 29. He had been chairman of the Department of Electrical Engineering since 1925.

George Klemperer, 81, retired professor of internal medicine, University of Berlin, where he was active in cancer and metabolism research, died December 24 in Boston. He retired in 1933 and came to the United States in 1935.

Porter James Crawford, 51, director of the Caribbean region of the International Health Division, Rockefeller Foundation, died December 27 in Havana. Dr. Crawford joined the foundation in 1928 and until 1934 studied control of yellow fever in Brazil. During the next three years he worked on malaria control in Panama, and in 1939 was made regional director of the division.

Collins P. Bliss, 80, Scarsdale, N. Y. dean emeritus of the New York University College of Engineering, died December 28 at Tupper Lake, New York.

Christian I. Gunness, 64, head of the Department of Agricultural Engineering, Massachusetts State College, died December 21 of coronary thrombosis.

An Anglo-American agreement for the exchange of German technical information acquired by the two nations since VE-Day has been announced by the Commerce Department. Under the agreement representatives of each nation will be able to select from the other's storehouse of German scientific and technical documents which have been microfilmed. Requests for British documents should be addressed to the Office of Technical Services, Department of Commerce.

The International Committee on Weights and Measures met in Sèvres and Paris October 22–29 for its first session since 1937. Members from Roumania, Sweden and Jugoslavia, who had expected to attend, were unable to do so. From the Japanese member, H. Nagaoka, no news has been received since 1939. The remaining eleven members who took part in the session were Louis de Broglie of France; G. Cassinis, Italy; M. Châtelain, U.S.S.R.; E. C. Crittenden, U.S.A.; M. Dehalu, Belgium; W. J. deHaas, The Netherlands; E. S. Johansen, Denmark; W. Kösters, Germany; Z. Rauszer, Poland; M. Ros, Switzerland; and J. E. Sears, Great Britain. Albert Pérard, director of the International Bureau of Weights and Measures also attended.

Mr. Sears was elected president of the Committee and Mr. Dehalu permanent secretary until the next session in 1948. The position of sous-directeur of the International Bureau was re-established, and Charles Volet was appointed.

The International Bureau was able to continue its work with very little interruption during the war though rising costs and inability of some countries to pay their dues created financial difficulties. To meet these difficulties and also provide for the enlarged scope assigned to the Bureau in recent years the Committee recommended that the General Conference of Weights and Measures scheduled to be held in 1948 arrange for an increase in national contributions to the Bureau.

Technical problems considered by the Committee included practicability of adopting the wave length of some spectral line as the primary standard of length, the definition of units of heat, and revision of the international scale of temperature. Decisions were made to proceed with the adjustments of the units of electricity and light which had been planned for 1940, and introduce the new units into practice as of January 1, 1948.

The electrical units designated as "international" are to be replaced by "absolute" units derived directly from the basic mechanical units and consistent with them within the errors of measurement. The "international" units used in various countries are slightly different, and as a basis for comparisons mean international units were set up at the International Bureau before the war by taking means of the units maintained by the national laboratories of France, Germany, Great Britain, Japan, U.S.S.R. and the United States. The relations accepted by the International Committee for transferring from one system of units to the other are as follows:

1 mean international ohm = 1.00049 absolute ohms
1 mean international volt = 1.00034 absolute volts

Some questions have arisen regarding maintenance of the mean ohm since 1939, and precise relations of the various national units to the absolute values adopted are not yet certain. Differences from the above factors, however, will generally not exceed 1 unit in the last decimal. For the United States, for example, the conversion factor for volts will be 1.00033, while that for ohms will be approximately 1.00050. This makes the U.S. "international" watt equal to 1.00016 "absolute" or mechanical watts. For electrical measurements this relation is very exact, but the combined uncertainties of measurement of actual absolute magnitudes amount to several parts in 100,000, and the rounded factor 1.0002 may well be used when heat or mechanical energy is to be evaluated. The units of light to be introduced are the "new candle" and "new lumen," the magnitudes of which are fixed by taking the brightness of a black-body radiator at the temperature of solidification of platinum as 60 candles per square centimeter. For light differing in color from that given by this primary standard the values are determined by use of standard spectral luminosity factors previously adopted by the Committee. This new combination makes the primary unit about 1.8 per cent smaller than the old international candle as represented by carbon-filament lamps, but the difference becomes smaller at higher temperatures so that practically no change will be made in the ratings for ordinary tungsten-filament lamps in the United States.—*E. C. Crittenden,* Associate Director, Bureau of Standards, Washington, D. C.

NRC News

The Committee on Research in Endocrinology has announced that requests for grants-in-aid during the period July 1, 1947, to June 30, 1948 will be received until February 28, 1947. In addition to a statement of the problem and research plan or program, applicants are asked to submit infomation about method of attack, institutional support of the investigation, and uses to be made of the sum requested. No part of any grant may be used by the recipient institution for administrative expenses.

The Committee makes grants-in-aid of research in the general field of experimental and clinical endocrinology. Applications for support of research in the problems of sex in the narrower sense are not administered by this committee and should be directed to the Committee for Research in Problems of Sex of the NRC.

The Committee on Research in Endocrinology will continue to give consideration to the support of studies of the effect of sex hormones on nonsexual functions, e.g., on general metabolism and metabolism of steroid hormones. Application blanks may be obtained by addressing the Secretary, Division of Medical Sciences, National Research Council, 2101 Constitution Ave., Washington 25, D. C.

TECHNICAL PAPERS

Hypervolemia in Mice Bearing Transplantable Granulosa Cell Tumors[1]

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It has recently been reported (*1*) that the livers of mice bearing transplantable granulosa cell tumors of the ovary are extremely congested and are greatly increased in weight. Microscopically, it is seen that the liver sinusoids are extremely distended with blood, so that their width is several times that of the cords of the liver cells. At the advanced stage of this condition the liver cells undergo atrophy; some vessels become thrombosed, and necrosis of liver tissue supervenes. The hyperemia is not restricted to the liver, for the adrenal, ovary, and spleen are sometimes also extremely congested; but no organ above the diaphragm has been noted to be involved.

The massive hyperemia suggested an increase in the blood volume. This was determined by adapting the exsanguination-perfusion technic and the Evans blue (T-1824) technic to the mouse.

The data, summarized in Table 1, indicate a huge increase in the blood volume of animals bearing granulosa cell tumors, heretofore unknown to occur in any condition. Mice bearing any of four different types of tumors of comparable mass and vascularization possess blood volumes that do not differ appreciably from those of normal mice. This huge increase in blood volume is apparent even after simple exsanguination.

TABLE 1

Blood Volume in Mice

Mice	Exsanguination-perfusion technic			Dye technic		
	No. in group	Body weight %		No. in group	Body weight %	
		Extremes	Average		Extremes	Average
Normal	12	3.5–6.6	5.2	9	9.0–12.7	10.9
With granulosa cell tumors	24	7.3–35.8	13.6	10	9.7–54.6	34.3
With other tumors	10	3.7–11.0	6.9	6	6.9–12.4	9.0

The hematocrit values are normal, slightly increased, or decreased indicating that there is an enormous increase in both plasma and red cells.

There is a direct relationship between blood-volume values and congestive changes in liver as seen in sections. In mice with marked congestion, the blood-volume values, as determined by the exsanguination-perfusion technic, were 3.7–17.2 cc. (12.3–35.8 per cent of body weight); with moderate congestion, 2.0–9.4 cc. (7.3–21.3 per cent of body weight); and with slight congestion, 2.0–3.8 cc. (7.6–10.8 per cent of body weight), as compared with 1.3–2.1 cc. in normal mice and 1.2–3.8 cc. in mice bearing other tumors.

It is possible that these granulosa cell tumors secrete a substance, as yet unknown, or a substance already known, which, when produced in ever-increasing amounts as the tumor grows, causes the hypervolemia. Such a substance is being sought.

It is possible that the vasodilatation accompanying hypervolemia is caused by an excessive amount of the vasodepressor material described in *Science* by Shorr, Zweifach, and Furchgott (1945, **102**, 489) and that the phenomenon is a disturbance of the homeostatic vascular mechanism related to shock.

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[1] This investigation was supported by the Donner Foundation, the Anna Fuller Fund, the National Advisory Cancer Council, and the Jane Coffin Childs Memorial Fund for Medical Research.

Streptomycin as an Aid in Isolating Influenza Virus[1]

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Hirst (*3*) used penicillin to thwart bacterial contamination in the isolation of influenza virus from unfiltered throat washings inoculated into the amniotic sac of the developing chick embryo. This same method was used by us to advantage in the type B influenza epidemic of November 1945.

Nose and throat washings obtained from three patients on November 20 were pooled, frozen on solid CO_2, thawed, ground in a mortar, and centrifuged. To each milliliter of unfiltered washings 500 units of penicillin were added, and 0.1 ml. of the mixture was inoculated into each of 24 twelve-day-old embryonated eggs. Of the 24 inoculated, 8 were alive after two days incubation. The live, embryonated eggs were tapped after two days incubation at 35° C. and again on the third day, and were found to contain influenza virus, type B, by Salk's (*4*) modification of the Hirst (*2*) hemagglutination and antihemagglutination test.

Because of the high death rate of the embryos experienced above, we added 1,000 units of streptomycin/ml. of washings in addition to the 500 units of penicillin. By use of both antibiotics we reduced our losses to less than 10 per cent of the inoculated embryos.

Subsequently both type A (isolated in Iowa City from 1943 epidemic) and type B (current strain) were tested in embryonated eggs to determine whether the streptomycin-penicillin combination interfered in any way with their propagation. We found as much virus produced in the presence of the antibiotics as with control eggs containing no streptomycin or penicillin.

Since that time we have used the streptomycin-penicillin

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[1] This investigation was aided in part by the Commission on Influenza Board for the Investigation and Control of Influenza and Other Epidemic Diseases in the Army, Preventive Medicine Service, Office of the Surgeon General, U. S. Army, Washington, D. C.

combination on a number of unfiltered specimens, including nose and throat washings, sputum specimens, and 10 per cent lung suspensions, when amniotic sac inoculations were desired. The death rate of the embryos and the incidence of positive cultures from embryonic fluids have been considerably lower when the two antibiotics were used than when penicillin alone was used. In fact, the occurrence of bacterial contamination when both antibiotics were used has been uncommon. One example has been encountered in which the combined antibiotics failed to protect the embryos in any degree. In this instance we inoculated embryonated eggs with a 10-per cent lung suspension from a human case of suspected influenzal pneumonia terminating fatally. All embryos died in 24 hours. The bacterial contaminant was a strain of *Pseudomonas pyocyanea*, which proved to be very resistant to streptomycin.

In some of our virus studies we have had occasion to pass mouse lungs at short intervals (24–48 hours) for a number of passages. Almost without exception we have encountered difficulty from bacterial pneumonias. However, when passages were made at 96-hour intervals, this difficulty was not encountered. We have assumed that these pneumonias arise as a result of washing bacteria from the upper respiratory tract of the mouse into his lungs as a result of the intranasal inoculation. The 24- and 48-hour intervals do not allow sufficient time for the mice to eradicate these organisms, and the rapid passages probably increase the virulence of these bacteria to the point at which they can kill the animal. Almost without exception the offending organism has been an alpha-hemolytic streptococcus or a small gram-negative rod (not *Salmonella*). Recently we have obviated the difficulty encountered in rapid lung passages by the addition of 500 units of penicillin and 1,000 units of streptomycin/ml. of 10 per cent mouse lung used for passage. The antibiotics and lung suspension are usually allowed to contact each other for about one hour before inoculations are made.

TABLE 1

Cultures of Mouse Lung

Time of sacrifice after intranasal inoculation	With antibiotics		Without antibiotics	
	Aerobic	Anaerobic	Aerobic	Anaerobic
24 hours	No growth	No growth	50 colonies[*]	32 colonies
48 hours	4 colonies	No growth	144 colonies	400 colonies

[*] The colonies consisted of nonhemolytic gram-negative rods, alpha-hemolytic streptococci, and anaerobic streptococci.

To check on the above technic we have inoculated two groups of mice (10 in a group) with 10 per cent normal mouse lung suspension intranasally. In one group the two antibiotics were added to the normal lung suspension before the inoculation. The other group served as a control. After 24 hours five mice from each group were sacrificed, their lungs pooled and ground to a 20-per cent suspension in saline, and one loopful of the suspension cultured aerobically and anaerobically. The remaining mice were tested in 48 hours. The results are shown in Table 1.

Addendum. Since submission of this article to the Surgeon General's Office for publication an article has appeared (*1*) in which the authors reported that they found streptomycin without toxicity for chick embryos and that there were no untoward effects on influenza virus, types A and B.

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Meteorite Impact Suggested by the Orientation of Shatter-Cones at the Kentland, Indiana, Disturbance

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A large quarry about two miles east of Kentland, Newton County, Indiana, exposes the center of a well-known local area of intensely deranged Paleozoic beds in a region of essentially flat-lying strata. It is generally accepted that a violent natural explosion in the geological past formed this (*3*, *4*) and similar disturbances (*2*, *5*). The application of violent shock in the formation of the Kentland disturbance is indicated in part by the jumbling of the strata, the shattering of the limestones, and the pulverization of the sand grains of the St. Peter sandstone. Although there is no indication of the presence of igneous material or of hydrothermal alteration, Bucher (*3*) and Shrock (*4*) have ascribed the origin of this disturbance to a deep-seated explosion of gases derived from an igneous intrusion. The observation made recently by the present writer may invalidate such a cryptovolcanic explosion hypothesis or any other suggested mode of origin that involves a deep-seated force acting from below the strata.

Prominently developed in the limestones at the Kentland disturbance are cup-and-cone structures called "shatter-cones," "pressure-cones," or "shear-cones," which were apparently produced by the explosive shock which formed the disturbance. These curious shatter-cones are present in two other explosion disturbances of the Kentland type but are not reported from other types of geological disturbances. If well developed, these structures consist of a large primary cup-and-cone which has a surface grooved in such a manner as to appear as a series of smaller secondary, overlapped and imbricated half-cones, with the apexes of these secondary features pointing toward the apex of the primary cup-and-cone. This convergingly-grooved surface is a fault surface similar to the parallel-grooved slickensided surfaces common in fault zones. An examination of the cup-and-cone surface and of the base of some of these features reveals that the cup is displaced relatively downward, *i.e.* away from the apex, with respect to the cone, so that these are normal faultlets rather than thrust faultlets. By applying Hartman's law, which states in part that under nonrotational forces the acute angle formed by shear planes in brittle material is bisected by the axis of maximum stress, it is apparent that the axis of such a primary cup-and-cone is also the axis of maximum stress. An examination of many of these structures at Kentland revealed that the axes of the primary cup-and-cones are invariably oriented *normal* to the bedding and the apexes point toward the *top* of the bed. The common orientation of the apexes indicates that the deforming stress was unidirectional. A consideration of the mechanics of this type of deformation shows that the cup was active and the cone passive, and that the shock was applied from the direction in which the apexes point. Therefore, the orientation of the shatter-cones suggests that, assuming that the beds were essentially horizontal prior to deformation, the shock force resulted from some type of explosion directly above the beds rather than from a cryptovolcanic explosion below the beds.

A probable interpretation for the observed orientation of these shatter-cones is that the Kentland disturbance is the "root" structure of a meteorite crater which was formed after late-Paleozoic time and deeply eroded prior to the Pleistocene. In fact, it is difficult to conceive of any other type of explosion than that of a large meteorite which would act from above the strata. Boon and Albritton (*1*) have developed evidence to show that structures of the Kentland type are the product of a meteorite impact. According to these writers, high-velocity impact, many times faster than the velocity of a shock wave in any type of rock, compresses the rocks elastically, rather than deforming them plastically, after which they are "backfired" into a damped-wave disturbance. Shatter-cones pointing toward the impinging body may be formed during the initial or compressional stage of such a meteoroid impact.

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Evidence That the Hemolytic Anemia Caused by Fat and Choline Is Not Due to Lipotropic Action[1]

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Johnson and co-workers (*6, 7*) have shown that the feeding of fat to dogs increases the fragility of their red blood cells and causes an increased destruction of erythrocytes as judged by an increased output of bile pigment. The hemolytic agents from fat are presumably fatty acids and soaps which have escaped resynthesis into neutral fat during absorption (*4, 5*). Although a high fat diet does not by itself produce anemia, Dupee, *et al.* (*3*) have shown that it can produce hyperplasia of the red bone marrow in dogs.

We have demonstrated (*1, 2*) that the administration to dogs of choline chloride in addition to a high fat diet causes the rapid development of an acute hemolytic anemia, accompanied by a rise in the icterus index, which rapidly regresses upon cessation of administration of either the fat or the choline (if the latter has not been fed for more than 8 or 10 days). To explain the mechanism of the production of this anemia, we have postulated that the choline exerts a "holding" action upon the bone marrow to prevent any great increase in its rate of erythropoiesis, while the fat furnishes products which cause the actual hemolytic destruction of erythrocytes.

Our experiments did not preclude the possibility that choline might exert its lipotropic action with the fat and thereby, in some manner, produce anemia. The present investigation was made to test this possibility, by the administration of atropine, which does not antagonize the lipotropic action of choline, but does block its pharmacologic vasodilator action.

Normal erythrocyte counts and hemoglobin percentages (Sahli) were determined, over a period of days, on one splenectomized and two normal dogs. The three animals were then given 60 grams of fat,[2] and 10 mg./kg. of choline chloride daily, in addition to their regular adequate diet. After the first day of the experiment, two of the dogs were given daily subcutaneous injections of atropine sulfate (0.5 mg./kg.) in addition to the orally administered choline and fat. Erythrocyte numbers and hemoglobin concentrations were determined daily on the blood of each dog during the experimental period.

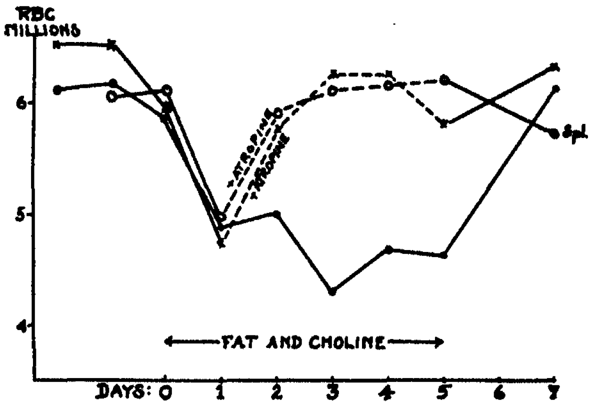

Fig. 1. The effect of atropine upon the erythrocyte counts of dogs rendered anemic by fat and choline. Dashed lines indicate periods during which atropine, in addition to fat and choline, was administered to two dogs. Open dot line (labeled Spl.) represents erythrocyte numbers of a dog which had been splenectomized about one year prior to this experiment.

It will be seen in Fig. 1 that the feeding of fat and choline caused reductions in the erythrocyte numbers of the three dogs, as observed about 24 hours after the first daily doses. At this time, two of the dogs were started on daily doses of atropine in addition to the choline and fat, and as a result, their erythrocyte numbers (dashed lines, Fig. 1) returned to normal within two days. The third dog, whose erythrocyte count is recorded as a solid line throughout Fig. 1, did not receive atropine and remained anemic during the period of fat and choline feeding. Hemoglobin percentages were observed to change proportionately to the erythrocyte counts.

Since atropine was shown, previously, to prevent or abolish the hyperchromic anemia which was produced more slowly by the administration of choline alone (*1*), we rather expected that it would also antagonize the hemolytic anemia induced by fat and choline, as it actually did in this experiment.

We believe, therefore, that in these experiments, choline acts by the mechanism previously postulated (*1*), *i.e.* as a weak brake to inhibit any acceleration of erythropoiesis which may normally follow the hemolytic destruction of red blood cells. It probably does this by causing vasodilation and improved blood and oxygen supply to the bone marrow, thus tending to depress erythropoiesis.

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[1] Research paper No. 826, Journal Series, University of Arkansas.

[2] Wilson's "Advance," a shortening made from animal and vegetable fats.

It is concluded that choline aids in the production of this anemia, *not* by virtue of a lipotropic action, but rather by its vasodilator or pharmacological action.

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A Nonrespiratory Variant of *Saccharomyces cerevisiae*[1]

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In studies of the toxic effect of ethylene oxide on a strain of *Saccharomyces cerevisiae*, it was noted that, at a time when almost all of the yeast cells in a suspension have been killed by the poison, some of the surviving cells give rise to colonies unlike those of the original organism. These colonies are smaller and rougher than the normal type. The organisms in them are usually more spherical, somewhat smaller, and in some cases occur in clusters. When restreaked on agar plates, they gave rise to colonies showing much variation in size. The ethylene oxide-induced variants can be obtained repeatedly from the original strain after repurification of the latter and thus do not represent a constant degree of contamination.

The occurrence of mutated colonies has been described before (*2, 3*) and interpreted as being due to the development of haploid yeast cells. However, such variation is usually observed only after sporulation of the yeast is followed by isolation on special media or by dissection and cultivation of individual ascospores.

In a few instances we have observed what appeared to be fusion between cells of the variant colonies to form a diploid yeast. Haploid yeasts are often unstable, not only because of possible conjugation but also because of the high rate of mutation to which they are subject. Instability has been noted in the variants obtained in this work and has led to difficulties in studying them. However, certain strains of the apparently haploid type have been sufficiently stable to be examined in some detail, and one, which did not undergo further variation over a period of several months, has shown very interesting characteristics.

Unlike suspensions of the parent strain, resting suspensions of this variant show no ability to oxidize either glucose or alcohol under aerobic conditions. In any case, the respiration is so slight that it is not measurable in Warburg respirometers. This is true even when the organisms have been grown in a shaking liquid medium containing 0.5 per cent glucose and 5 per cent yeast autolysate and have been harvested during the period of exponential growth. As will be seen in Table 1, the rate of fermentation is high, and no Pasteur effect can be observed.

Suspensions of the parent yeast examined spectroscopically show absorption bands corresponding to reduced cytochromes A, B, and C at 605, 552, and 563 A. Similar suspensions of the variant show a strong band at 563 A. (cytochrome C), but lack the other two even when reducing agent is added in excess.

TABLE 1

RATES OF RESPIRATION AND FERMENTATION OF PARENT AND VARIANT STRAINS AT 30° C. WITH 2 PER CENT GLUCOSE AND 2 PER CENT KH_2PO_4

	Parent	Variant
Q_{O_2}	42.5	0
$Q^{air}_{CO_2}$*	62	274
$Q^{CO_2}_{CO_2}$	145	268

* Only aerobic fermentative CO_2 production included in $Q^{air}_{CO_2}$.

In addition, the variant gives no test for indophenol oxidase with Nadi reagents according to the method of Keilin (*1*). The parent strain gives a strong positive reaction under identical conditions. Spectroscopic examination for cytochrome oxidase was not made.

The variant can ferment the same sugars as the parent strain and use them as substrates for growth. As might be expected, however, it does not grow with alcohol as carbon source, although the parent strain is able to do so. Morphologically, it differs in size and in the shape of the cells (parent—(4.2–7.2) × (5.5–10.8)μ; average: 5.5 × 7.2μ; variant—(4.2–6.6) × (4.8–8.4)μ; average: 5.3 × 6.2μ). While the thallus of the parent strain occurs as single cells and pairs, that of the variant consists of clusters of from 3 to 20 cells. In old liquid wort cultures, the variant shows no surface growth or ring formation. There are also noticeable differences in gross morphology of streak and giant colonies. The variant has lost the ability to form ascospores.

The question as to why these haploid variants, if such they are, appear after ethylene oxide treatment has not been satisfactorily answered. It might be the result of a specific metabolic effect of the poison on the yeast cells, but it seems more likely that haploid cells or spores may be present in the normal cultures and survive the treatment with ethylene oxide better than the diploid cells because of their slightly greater resistance to the poison. Since the particular variant discussed occurs in clusters of various sizes, it is difficult to compare its death rate in ethylene oxide with that of the original strain by the use of viable counts. Since any difference in resistance cannot be great (all of the yeast cells are eventually killed by ethylene oxide), they are difficult to establish by ordinary statistical methods. However, in studies with another variant, which had similar physiological characteristics (*i.e.* absence of oxida-

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[1] A report on a joint research project of the Quartermaster General's Office, U. S. Army, and the University of California. The authors wish to express their appreciation to Prof. Gordon Mackinney for his aid with the spectroscopic work and to Miss Ruth Alleman for technical assistance.

tive metabolism) but which did not form clusters, an apparently slightly greater resistance to the poison was found than with the parent strain.

Castor (*4*) has described a nonrespiratory yeast variant resulting from treatment with HCN. In contrast to our variant, his organisms lacked cytochrome C. Ethylene oxide does not appear to act as a specific respiratory poison. However, although its effect on the metabolism of yeast, unlike the effect of HCN, appears to be general, it does inhibit fermentation more rapidly in the presence of air than in its absence. Not all of the morphological variants appearing after ethylene oxide treatment lack oxidative metabolism. Several of these showed Q_{O_2} values comparable to that of the original strain.

If greater resistance to the poison explains the appearance of such variants, it may be that only certain types of haploids will be found by this method. To study all of the types found, particularly in view of their further mutation, would be out of the scope of our work. However, the strain discussed, providing its physiological characters remain stable, offers many interesting possibilities for investigation.

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The Deposition of C^{14} in Bone[1]

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In the course of experiments on the mineral metabolism of bone salt in rats, we made some observations on the deposition of C^{14} in bone which are worth recording now, although our studies are incomplete.

Beginning in July 1945, we injected a number of rats intraperitoneally with $BaCO_3$ or $NaHCO_3$ in which 75–150 μc. of C^{14} were present. Some of the rats (weighing 52–75 grams) had been on a normal diet; others, on a low-phosphorus, vitamin-free diet before the injection. All animals were on a normal diet thereafter. The rats were killed at 3 days and 2, 4, 8, and 16 weeks after injection. Among the controls were rats injected with P^{32} or Sr^{89}. The bones, after fixation in absolute alcohol and embedding in nitrocellulose, were sectioned *without decalcification* by the routine of McLean and Bloom (*1*). Autoradiographs of these sections as well as of the alcohol-fixed soft tissues were prepared for us by Mr. George Svihla. We found no differences in the results dependent on the normal versus the low P diets.

As was expected from previous studies on the deposition of bone salt as shown by staining with $AgNO_3$ and by the use of Sr^{89} and other calcium substituting isotopes, we found in the autoradiographs of the long bones of rats killed after 3 days that Sr^{89} deposits most heavily in the metaphysis (extending through the calcified cartilage and all of the spongiosa) and is present in smaller amounts in the bone structures of diaphysis and epiphysis. These differences in the amount of Sr^{89} in the several parts of the bone can be accounted for by the occurrence of two processes: (1) a fresh deposit of bone salt in the zone of new growth of bone in which Sr^{89} substitutes for some of the Ca atoms, and (2) an interchange between Sr^{89} and Ca of the bone salt previously deposited in the bone.

Autoradiographs made from rats injected with P^{32} show that P^{32} is deposited in much the same situations in bone as Sr^{89}.

The autoradiographs of the bones of rats injected with C^{14} show a markedly different picture from those of the Sr^{89} rats. Those from rats killed 3 days after injection of C^{14} show the shaft of the bones as black lines. The bone in the epiphysis is a faint gray, while the metaphysis of the growing end of the bone is negative, or practically so, leaving a gap of about 2 mm. between epiphysis and diaphysis. The nongrowing end of the bone is completely outlined in gray. The marrow cavity is so pale that it is probably negative. The autoradiographs of the 2-, 4-, 8-, and 16-week specimens show essentially the same picture as those after 3 days, except that the bones have grown in length and width. With the growth in length, the unblackened zone at the metaphysis increased to about 3 mm. at 2 weeks, 4 mm. at 4 weeks, 10 mm. at 8 weeks, and 12–17 mm. at 16 weeks. Since the blackened lines representing the lateral extent of the diaphysis at the time of injection are still present after 16 weeks, it would seem that the marrow cavity did not increase much in diameter at the site of deposition of radioactive carbon. However, new bone was deposited externally so that the bone as a whole increased in thickness.

Sections of the liver and kidney gave fairly intense autoradiographs at the 3-day and 2-week stages, but were negative after the longer intervals. Since the films were exposed for the same length of time, it would appear that there was approximately as much C^{14} in the bones after 16 weeks as after 3 days, while there was a great decrease in the C^{14} content of the soft tissues. Organ analyses are now being made.

From the autoradiographs of bones of these few rats we would conclude that C^{14} injected as carbonate appears primarily in those areas occupied by pre-existing bone. It does not appear in appreciable quantities in the areas of most recently deposited bone salt. This observation demands further study on the carbon metabolism of bone.

Since the C^{14} content of the bones did not decrease appreciably in 4 months, we believe that the health hazards involved in working with this isotope must be studied, particular attention being paid to the possible development of bone tumors.

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[1] This work was carried out under contract between the University of Chicago and the Manhattan District, Corps of Engineers, War Department.

[2] Now with the Argonne National Laboratory and the University of Chicago.

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IN THE LABORATORY

Apparatus for Studying Crystal Formation

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In an attempt to develop methods for studying some of the problems of mineral deposition, we have designed a simple apparatus which promises to be very useful in many different kinds of studies of crystal growth. Most recorded laboratory experiments on crystallization have made no attempt to simulate the conditions under which many crystals are formed in fissures and cavities in the earth. One of the most common mechanisms under natural conditions is precipitation by slow cooling from moving solutions. The apparatus is a first attempt to design an approximate earth model in which the effect of variables can be studied accurately.

The essential features of the apparatus are shown in Fig. 1. The material to be precipitated is ground, sized, dried, and weighed, then put in the pervious basket in the left arm above the heating coil. The heating coil is connected, and convectional circulation established as shown. The temperatures of the two arms can be controlled by adjusting the amount of heat by using various bulb combinations in the lamp bank and by adjusting the rate of flow of cooling water in the jacket surrounding the right arm. After a constant temperature gradient has been established and the solution is saturated at the lower temperature, a seed crystal is introduced at the coldest point of the right arm, and growth on the seed begins.

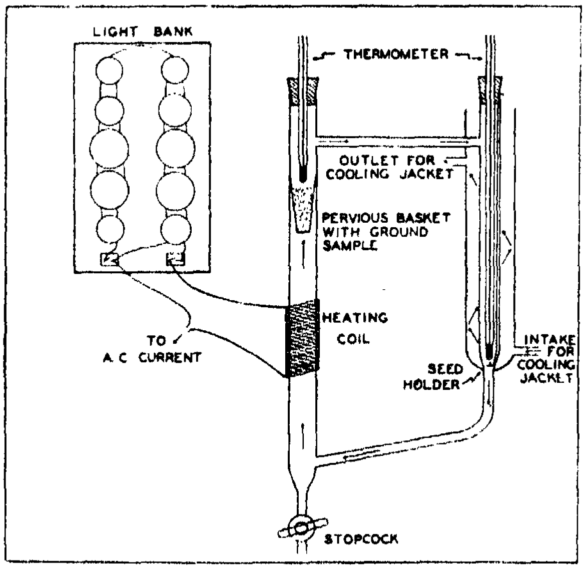
LIGHT BANK
THERMOMETER
OUTLET FOR COOLING JACKET
PERVIOUS BASKET WITH GROUND SAMPLE
HEATING COIL
TO A C CURRENT
SEED HOLDER
INTAKE FOR COOLING JACKET
STOPCOCK

Fig. 1

Many different kinds of studies can be made with the unit. Some of the obvious advantages over ordinary static precipitations might be mentioned. Operation is continuous, and the system is so stable that little adjustment is necessary after an original temperature setting. The apparatus is especially suited for studies of slightly soluble materials, since thousands of liters of solution can be passed through the sample. Preliminary work indicates also that many slightly soluble substances, which precipitate colloidally when formed by the mixing of ionic solutions, will crystallize fairly readily down a gentle temperature gradient such as that provided in the apparatus.

The device is now being used to study the effect of flow on crystal orientation and growth, the use of inclusions in crystals as a criterion of temperature of formation, and the rates of leaching of very slightly soluble minerals as a function of temperature. Many other possibilities suggest themselves, such as the response of crystal habit to different temperature gradients and the nature of replacement processes. A second model has been designed with adaptations to fit our specific purposes. This new model will have a plane-sided chamber at the point of crystal formation, so that the crystals can be photographed during growth and the prints pieced into a motion-picture film. In the first design, rate of flow and temperature differential of the two arms are interdependent, and the rate of flow changes with the grain size and total amount of material introduced for leaching. In the new design, rate of flow will be controlled by a diaphragm with adjustable permeability, so that flow and temperature differential can be kept constant, even though the permeability of the sample changes during the leaching process.

Antigenic Carbohydrate-Lipid Isolated From Paraffin-Oil Extract of Dead Tubercle Bacilli[1]

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A carbohydrate-lipid complex isolated from tubercle bacilli has been found to induce antibodies when injected into normal animals.

The experiments have been carried out, using as tools the two fractions of biological significance which were obtained from a paraffin-oil extract of dead tubercle bacilli (*1*). One fraction is called the "toxic" fraction, since as small an amount as $2\ \gamma$ is sufficient to produce lesions in the lung of normal guinea pigs when injected intraperitoneally in paraffin oil. The other is called the "sensitizing" fraction, as it gives to normal animals definite hypersensitivity to old tuberculin (and also to the whole bacterial cells) when injected intraperitoneally, in oil, in amounts as small as 0.1 mg. Both fractions were found in the oil extract. This oil extract was made in an attempt to elucidate the mechanism by which paraffin oil enhances the ability of dead bacilli to produce hypersensitivity and lesions. We presumed, and we found, that the oil extracts these fractions from the bacilli. Both were precipitated from the oil with dioxane.

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[1] This study was carried on under a grant from the Josiah Macy, Jr. Foundation.

The "toxic" fraction is the chloroform-soluble portion of the precipitate after it has been thoroughly washed with dioxane and methanol. It is a polysaccharide ester of mycolic acid, which still contains, after purification, 1.05 per cent of nitrogen and 0.4 per cent of phosphorus.

The "sensitizing" fraction is that part of the precipitate which is insoluble in the usual organic solvents, such as methanol, ethanol, ether, chloroform, benzine, and petroleum ether. It contains a large amount of protein. (We found later, when we tried to purify these fractions, that each one of them is not free of the other.)

Preliminary experiments led us to believe that the "sensitizing" material acted also as a protective antigen. A clear-cut acquired resistance was obtained in normal guinea pigs which had been previously immunized by the "sensitizing" fraction and which were then injected with 0.1 mg. of living bacilli of low virulence, H-37.

In further experiments the normal guinea pigs were immunized with a *more purified* "sensitizing" material. The hypersensitized animals were then given bacilli of *higher* virulence (H-160 Corper). They showed a certain degree of acquired resistance, not only in survival times but also by the degree of tuberculosis involvement of their organs. But in spite of the fact that in four successive experiments, each one involving at least 15 sensitized animals and 15 controls, we lowered the infecting dose to 1/50,000 mg., these animals failed to show the same degree of acquired resistance as that shown by the animals which were sensitized by the less purified material.

It was clear that something else in the "sensitizing" fraction than the sensitizing antigen might be responsible for the previously observed acquired resistance.

On the other hand, animals which were injected with the "toxic" material alone in oil showed an excellent acquired resistance against infection when they received living bacilli more than three months after they were injected. The effective dose of "toxic" fraction was 1 mg. in one single injection, or 2 γ in two successive injections at an interval of a few weeks.

Moreover, there was some evidence that the "toxic" material, the carbohydrate-lipid component, produced antibodies. Guinea pigs immunized with this "toxic" material, as well as animals infected with tubercle bacilli, reacted more to the intracutaneous injection of a few gamma of the "toxic" material than did normal controls.

These observations led us to believe that the acquired resistance developed in guinea pigs by the "sensitizing" material was due to contamination of this material with the carbohydrate-lipid complex.

Our speculations received considerable support when we observed that the water-soluble portion of the hydrolysate[1] of our carbohydrate-lipid complex reacted strongly, in precipitin tests, with the sera of rabbits and guinea pigs which had been injected with the "toxic" carbohydrate-lipid complex alone. Precipitations were obtained in dilutions as high as 1:10,000,000 with some sera. Strong precipitations were also obtained with the sera of a horse which had been immunized with whole tubercle bacilli and also with the sera of rabbits that had been immunized with human and avian tubercle bacilli, grown in the "tween 80" medium recently described by R. H. Dubos and B. D. Davis (*2*).

This is the first demonstration that a chloroform-soluble carbohydrate-lipid complex isolated from tubercle bacilli is antigenic, when injected into normal animals in paraffin oil. Our experiments showed that this carbohydrate-lipid complex aids the process of acquired resistance to the tubercle bacillus. Whether or not this complex is the essential immunizing antigen of the tubercle bacillus remains to be seen.

In any case, it will be a useful tool—a test—which may allow us to follow, *in vivo* as well as *in vitro*, the carbohydrate-antibody formation in the course of infection with the tubercle bacillus.

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A Technique for Obtaining Quickly Permanent Mounts of Nonembedded Botanical Material

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Plant pathologists and botanists are often embarrassed by being unable to preserve permanently material that has not undergone the classical technique of paraffin embedding. The former, for instance, of which the writer is one, would often wish to keep permanent mounts of such material as leaf scrapings or small fragments of bark, fruit, or freehand sections. These materials are usually preserved in a 7 per cent aqueous solution of potassium hydroxide. The mounts can be kept only temporarily even with asphalt lac seals.

As everyone knows, nothing can compete with balsam for permanent mounts, but with such material as is described above it is impossible to follow the classical procedure and, if this is not the case, one cannot always devote the time necessary for such inclusions.

The writer has adopted the following technique to circumvent the difficulty with most satisfactory results:

Slides that are worth keeping are first treated with chloralphenol (see M. Langeron. *Précis de microscopie.* (5th ed.) P. 607). This medium has the property of being miscible to water and balsam. Moreover, it is an excellent clarifying medium, and its miscibility to water makes it an excellent dehydrator. Droplets of this liquid are deposited close to the cover slip while the aqueous medium is pumped out with strips of filter paper. The slides are then slightly warmed to hasten the departure of air. The writer has found it convenient to lay them on the grating of a microscope lamp resistance. Levigation with chloralphenol is repeated until one can have the assurance that all the water is gone. Droplets of Canada balsam solubilized in xylol are then dropped on the site where chloralphenol has been previously deposited, the latter being in turn pumped out from under the cover slip with strips of filter paper. The slides are then heated at a slightly higher temperature to evaporate the chloralphenol. This must be followed closely so as to add fresh droplets as the xylol and chloralphenol evaporate. Finally the material is mounted in pure balsam and can be kept indefinitely.

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[1] Hydrolysis made in methanol 10 per centpotassium hydroxide.

Counterindication of this technique holds only for hyaline spores or mycelia which are scarcely visible in balsam. But wherever a slight coloration or a sufficiently thick membrane is present, details are sufficiently visible to permit taxonomical or anatomical observations.

There is another drawback to this technique when free spores are present on the slide. These can be displaced or drawn out from under the cover slip when the slide is levigated with the two media. When such is foreseen, one can place the material directly in a mixture of chloralphenol and balsam diluted in xylol in the proportion of two droplets to one. The chloralphenol insures the clarification of the material and the penetration of the balsam. With the cover slip on, the slide is gently heated until the chloralphenol has completely evaporated. Here again, attention must be paid to feeding fresh droplets of Canada balsam as the mounting medium dries up.

This latter procedure does not apply to fresh material but only to herbarium material or one that has been dried beforehand.

This technique has been very useful to the writer to prepare quickly permanent mounts of abundant herbarium material that had to be examined at short notice, while keeping a permanent record of the observations.

Chloralphenol is prepared by mixing by weight two parts of chloral hydrate to one part of phenol crystals. The mixture, liquefied by gently heating it on a flame, can be kept in dropping bottles.

This technique may not be totally unknown, as Langeron seems to infer. In any case, the writer has seen no reference in the botanical or phytopathological literature to its having been used.

Fluorophotometric Determination of Rutin and Other Flavones

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A great deal of interest has developed in the therapeutic use of rutin for the treatment of reduced capillary resistance in certain hemorrhagic diseases (*1*, *3*). Rutin is a flavone glucoside which yields quercetin, glucose, and rhamnose on hydrolysis with dilute acids (*2*). Most flavones react with boric acid to form highly colored derivatives which can be adapted to colorimetric determinations (*5*, *6*). We have applied the boric acid reaction to the determination of rutin and have also improved the sensitivity of the method by measuring the intensity of fluorescence with a photometer, instead of measuring the optical density of the colored solution. We have also found that the fluorometric method can be used to advantage with purified quercetin, and presumably with other flavones which react with boric acid.

A stock solution of recrystallized rutin[1] in dry acetone was diluted to give a series of standards containing known concentrations of rutin. The boric acid reagent was prepared by mixing equal volumes of a saturated solution of boric acid in acetone and a 10 per cent citric acid solution in acetone, as described by Wilson, Weatherby, and Bock (*6*). The reagent was added to the rutin standards in the ratio of four volumes to one of rutin solution. Colorimetric measurements were made with a Klett-Summerson photoelectric colorimeter using a blue filter (No. 42), and the fluorescence measurements were made with a Pfaltz and Bauer Model B fluorophotometer. The mercury vapor light in the fluorophotometer was passed through a set of filters having a peak transmission in the violet band at 430–440 mμ. The degree of fluorescence was measured with a photocell through a yellow filter having a sharp cutoff at 520 mμ. Fluorescence was also observed using ultraviolet light below 370 mμ; but the photometer readings were higher with the violet light source which was finally chosen for this work. The rutin-boric acid solutions exhibited a green fluorescence which, on examination with a spectroscope, appeared to extend from 510 mμ to 620 mμ.

Calibration of the fluorophotometer with rutin standards produced the results shown in Table 1. The degree of fluorescence appears to be directly related to the concentration of rutin and affords a convenient method for its determination. The advantages of fluorimetry over colorimetry are also demonstrated in Table 1, where the readings with different concentrations of rutin are compared. However, the borocitric reagent itself exhibits some fluorescence which varies with different lots of reagent (*6*). The effects of moisture, concentration of reagents, time of standing, and other variables have been worked out, and the fluorimetric method is now being applied to the determination of rutin in biological materials, using procedures for extraction similar to those already developed for flavones (*4*, *6*).

TABLE 1

Comparison of Fluorimetric and Colorimetric Readings With Rutin-Boric Acid Solutions

Rutin/ml. sample (μg.)	Colorimeter readings	Fluorimeter readings
10.0	27.0	67.0
8.0	22.0	55.0
6.0	17.0	43.0
4.0	12.0	30.0
2.0	8.0	16.0
1.0	5.0	9.0
0.50	3.5	5.5
0.25	2.0	4.0
0.10	1.0	3.0
0	0	2.0

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[1] The rutin used in these experiments was obtained through the courtesy of Dr. M. J. Copley, Eastern Regional Research Laboratory, U. S. Department of Agriculture, Philadelphia.

Metabolism Cages

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In laboratories which only occasionally engage in metabolism experiments with rats, it may be difficult to obtain quickly a suitable arrangement of cages. The unit to be described is efficient, easily constructed, and requires few items not usually stocked. The complete unit has gradually evolved over a period of years, and therefore proper credit cannot be given to individuals who have contributed ideas.

The ordinary round cage used in nutrition experiments may be used (Fig. 1). This cage, as shown, has an efficient watering device, but the trough, unless cleaned often, tends to accumulate particles of food from the mouth of the rat. If this is objectionable, a drinking tube may be pushed between the wire meshes in the top of the cage, with an inverted bottle outside the cage. The food receptacle is held in place against the cage by a weak spring, which encircles the upper part of the jar. The spring also permits easy removal or replacement of the food jar. For most of our work we use half-pint Mason jars, with Kerr screw caps, a circular opening, 3.5-4 cm. in diameter, being cut through the center of each lid. Although the lids may be dispensed with, their use often helps prevent the animals from throwing out and wasting food.

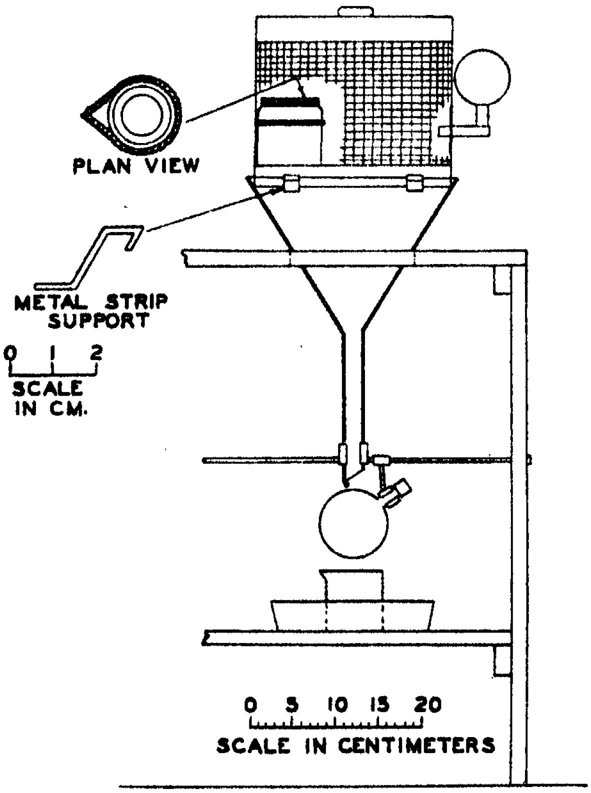

Fig. 1. Arrangement of metabolism cage and stand.

The cage rests upon four strips of stainless steel or other metal (each about 12 mm. wide), bent on one end to fit over the edge of a funnel, 250 mm. in diameter, and bent up on the other end to form a firm ledge for the cage bottom. These strips may be lifted off for cleaning. The glass funnel fits into a hole in the wooden stand and is gripped by a burette clamp near the lower end of the stem. A 200-ml., round-bottom, short-ring flask (balloon flask) is held by a burette clamp beneath the stem of the funnel. Feces drop between the meshes of the cage and, falling through the stem of the funnel, are deflected by the rounded surface of the flask into a pan or large evaporating dish. Urine passes down the funnel onto the surface of the flask and follows the curve of the flask to the lowest portion, whence it drips into a beaker, or Erlenmeyer flask, placed directly beneath the balloon flask.

The wooden stand, 109 x 63 x 30.5 cm., has three openings, 15.2 cm. in diameter, to support the funnels, and a shelf 19 cm. from the floor to support the receptacles for the urine and feces. A metal rod, 0.9 cm. in diameter and 38 cm. from the floor, runs the entire length of the stand. To this rod are fastened the various burette clamps.

The stand described is designed for three cages, which provides a unit easily moved by one person and conveniently stored.

Sharp Interfacial Precipitin Reactions in Capillary Pipettes[1]

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The capillary pipette precipitin technique, which was developed for grouping and typing hemolytic streptococci (*2*), has proven adaptable to other investigations in which precipitin tests are required. The obvious advantages lie in the great saving of both precipitating serum and bacterial extracts or other antigenic substances. With moderately to strongly reacting reagents, easily detectable precipitates are formed in capillary pipettes having an external diameter of 1.0 ± 0.02 mm., in which the two reagents readily mix. With weaker precipitating sera, or with sera in which prozoning is liable to occur, particularly with those which react with the group-specific carbohydrates of streptococci, it is often necessary to employ larger capillary pipettes (*i.e.* 1.5 ± 0.02 mm.). With such pipettes, however, it is frequently difficult to obtain as clear-cut reactions as occur in small test tubes in which the antigen is carefully layered over the serum so that a sharp ring of precipitate forms at the interface between the two reagents (*1*). It has long been recognized that ring, or interface precipitin reactions are at times convenient in developing satisfactory precipitin tests. A difficulty encountered in trying to obtain sharp layering in capillary pipettes is the tendency for the two reagents to mix—a tendency roughly proportional to the movement of the interface. This move-

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[1] This investigation was carried out under a contract between the Rockefeller Institute for Medical Research and the Commission on Hemolytic Streptococcal Infections, Board for the Investigation and Control of Influenza and Other Epidemic Diseases in the Army, Preventive Medicine Service, Office of The Surgeon General, U. S. Army.

ment is held to a minimum in the larger pipettes by the following modifications:

Pointed capillary pipettes are made from tubing, 1.5 ± 0.2 mm. in external diameter, which is broken into lengths of about 13 cm.[2] The middle of each length is heated in a narrow flame, such as is made by a fishtail burner or the pilot of a Bunsen burner, and, when melted, drawn to a very fine point by quickly pulling on the two ends of the tubing. When cool, the very finely drawn glass is broken close to the conical tip; thus, two conically pointed pipettes are formed with fine openings about the diameter of a hair. To insure that these openings are patent, they may be inspected with the aid of a hand lens. With practice, three to four such pairs can be drawn at one time. The outer surface of these pipettes is cleaned with paper tissue, the pipettes then being placed in test tubes containing absorbent cotton on which the conical points rest. These containers are capped with unsized paper and then sterilized by dry heat, or by autoclaving followed by drying in an incubator.

For testing, the sterile pointed end of a pipette is dipped into the precipitating serum until a column of serum between 1.0 and 1.5 cm. long has been slowly drawn in by capillary action, then wiped with paper tissue and dipped into a drop of antigen solution until an equal amount has been drawn into the pipette. Air bubbles must not separate serum and antigen solution. This conical end is again wiped and plunged into a lump of plasticine in order to seal the hair-sized opening. The lower end of the pipette is pressed against a strip of plasticine, which has been previously placed on a block of wood, so that the pipette is held in a vertical position without being plunged into the plasticine. If it is mounted in this manner, the fluid in the upper part of the pipette will not be forced out by air pressure which would be developed were the lower open end forced directly into plasticine. The upper end should, however, be inspected to see whether any solution has been forced out, and if this has occurred, it should be wiped off so that no film will be deposited on the pipette.

If this procedure has been followed, the column of fluid will remain at the upper part of the pipette, the surface of which should be perfectly clean.

The above-outlined technique insures the minimal mixing of the underlying serum and overlying antigen solution; hence, there is a narrow zone in which the precipitate forms. When longer columns of serum and antigen are drawn into the capillary pipette, this interzone moves over a proportionally wider range, more mixing of the two reagents occurs, and the zone of precipitate is wider; hence, the reaction may be less intense. The same tendency to mixing of the two reagents exists when the reaction is set up, as previously advocated, in 1.5-cm. pipettes with both ends wide open: rapid mixing of the two reagents occurs, and the reactions may be so indeterminate that they often require confirmation in small test tubes.

Within 5 to 10 minutes a positive reaction is shown by a cloudy white disc of very fine precipitate at the junction of serum and antigen. With weak sera or antigens, a longer time may be required. When testing with streptococcal grouping sera, if the pipettes are placed in the incubator at 37° C. for an hour, weak cross-reactions with sera of other groups sometimes occur; hence, readings made within 5 to 10 minutes probably indicate more specifically the group to which the streptococci under examination belong. Upon standing, the precipitate formed early may redissolve, or it may clump, fall to the bottom of the serum, and be detectable the following morning after refrigeration.

Errors due to weak reactions may result from excessive mixing of the antigen and serum. Another source of error at times is to allow the test to stand too long before reading, because the precipitate formed early may redissolve. False readings may result from grease marks or other materials on the outer surface of the tubes over the zone of reaction. Antigens and sera should always be clear before preparing the test, since hazy sera, or sediment drawn into the pipettes with the reagents, may lead to false-positive readings.

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Warm Safranine for Plant Tissues

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In the course of recent botanical investigations conducted at the University of Michigan Biological Station, an attempt was made to decrease the length of time necessary for staining plant slide material with safranine. The slides and safranine were placed in a paraffin oven which was thermostatically controlled at 53° C., and a series of tests were made subjecting different materials of different thicknesses to varying lengths of time in the heated safranine. The procedure up to and following the safranine bath conformed to the norm.

The results indicated that completely satisfactory staining could be obtained in 15 minutes as compared with the 24- to 48-hour period necessary when the stain is used at room temperature. The color imparted by the warm stain is quite brilliant and remains fast in the tissue even through prolonged immersion in absolute alcohol. Young *Lycopodium* stem, ordinarily difficult to stain, showed excellent results after 15 minutes in the heated stain. Other material tested included hypocotyl of collard, stem of *Prenanthes alba*, and stem of *Diervilla Lonicera*.

Other tests showed that successful staining could be accomplished when the slides were left in the safranine for periods up to 3½ hours. However, material left in for 12 hours was overstained, resulting in a deep purple color which was not readily distinguishable, under low power, from the fast green used as a counterstain.

As the heat induces a rapid and thorough penetration of the dye, the excess stain is not as rapidly removed as under room temperature, and it is desirable to leave the slides in absolute alcohol for a somewhat longer time than is usual. For the same reason, the normal 1- to 2-minute immersion in fast green was increased to 3–10 minutes.

A brief examination of the literature indicates no previous mention of the possibilities of using warm safranine for botanical preparations, although Lee (*1*) mentions its use for zoological preparations by Griesbach in 1887.

Reference

1. LEE, B. *Microtomist's vade-mecum*. (9th ed.) Philadelphia: Blakiston, 1928.

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[2] This capillary tubing is carried in stock by Arthur H. Thomas, Philadelphia.

Book Reviews

The diffraction of X-rays and electrons by free molecules. M. H. Pirenne. Cambridge, Engl.: at the Univ. Press; New York: Macmillan, 1946. Pp. xii + 160. (Illustrated.) $3.00.

The diffraction of electrons by free molecules has been used so extensively in recent years in the study of interatomic distances that it is both useful and refreshing to have a reminder of other aspects. This volume contains an excellent presentation of the physics of the diffraction of X-rays by free molecules. Although it is based entirely on previously published material, it is useful to have this material brought together in one handy volume. Included is a treatment of coherent and incoherent scattering by a free electron, by an atom, by free molecules, and by gases and liquids where the intermolecular effects are not negligible, as well as the effect of thermal motions and the Faurier method of analyzing diffraction data. The mathematical development tends to be somewhat cursory; too often the function under discussion is stated without its derivation being shown. On the other hand, the physical interpretation of the functions is very thorough, and the comparison with experimental data is especially good in the careful statement of the limitations on interpretation imposed by the assumptions inherent in the theory.

The treatment of electron diffraction is not parallel with that of X-rays. Of the 13 chapters, 10 deal exclusively with X-rays. The theoretical treatment for electrons is very brief, and there is no counterpart to Chapter XII, on the experimental technique of X-ray diffraction, and to Chapter XIII, which lists the molecules studied by X-ray diffraction.

No prospective author of a work describing the technique and analyzing the reliability of the results of electron diffraction need be discouraged by the present book.

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Qualitative analysis by spot tests: inorganic and organic application. (3rd Engl. ed., rev.) Fritz Feigl. (Translated by Ralph E. Oesper.) New York-Amsterdam: Elsevier Publishing Co., 1946. Pp. xvi + 574. (Illustrated.) $8.00.

This third English edition of Dr. Feigl's well-known book on spot tests is the result of a revision of the previous issue which has been expanded to include "the newer spot reactions, together with details of the pertinent procedure and applications." The two previous English editions were translated by Dr. Janet W. Matthews. A change of translators became unavoidable because of the difficulties of communication between Brazil and England, and because of the decision to have the printing done in the United States. A large part of the translation by Matthews is, however, retained in the text.

New features of the third edition are the sections on "Working Methods and Special Aids in Spot Test Analysis," "Tests for Free Elements," and "Bibliography on the Application of Spot Reactions for Special Scientific or Technical Purposes." The first is taken from the author's *Laboratory manual of spot tests*, published by the Academic Press, Inc., New York City. The general usefulness of this section must be granted, but the aid of a standard text on microtechnique will be desirable whenever the performance of involved separations should become necessary. The Bibliography contains references to 21 books and 134 articles published in journals. As far as is feasible—and this holds for the whole book—references to *Chemical Abstracts* replace the former references to *Chemisches Zentralblatt.*

A listing of the principal sections may serve to indicate the directions in which the text has expanded: Working Methods and Special Aids (8–40); Tests for Metals (41–190); Tests for Acid Radicals (191–271); Tests for Free Elements (272–281); Systematic Analysis of Mixtures (282–308); Qualitative Organic Analysis (309–424); Application in Tests of Purity, Examination of Technical Materials, and Studies of Minerals (425–488); Bibliography on Applications (489–495); Tabular Summary of the Limits of Identification (496–509); Author Index (511–518); and Subject Index (519–574). In the section on organic analysis, 10 pages are devoted to the detection of elements, 73 to the detection of characteristic groups, and 32 to a description of the identification of specific compounds.

The author has tried to present the entire literature on spot tests in order to give the reader a rapid survey of the whole field, but it is interesting to observe that the stimulating articles of B. L. Clarke and Hermance as well as those of H. Yagoda completely failed to deflect the author from his traditional course. The text has been expanding ever since publication of the first German edition in 1931, but its general trend has remained unchanged.

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Faune de l'Empire française. Paris: Museum d'Histoire Naturelle, 1943–. Vol. 1 + .

French zoologists must accept from their colleagues in other countries not merely congratulations but profound admiration and gratitude that throughout the difficult conditions of war and of their country's occupation they have been able to continue the well-known *Faune française* and to launch a parallel series dealing with the possessions, colonies, and protectorates that form their worldwide, in larger part tropical empire.

The rich collections which have been received from overseas for more than a century and which have accumulated in the Museum d'Histoire Naturelle de Paris, serve as a basis for the enormous research contemplated and well begun in the preparation of this series. The entrepreneurs estimate that in less favorable cases more than half of the fauna of these diverse regions is already known; and in many others, almost the total.

The series was initiated in 1943 by a volume on the Orthoptèroïdes of North Africa, by Lucien Chopard, the one man in the world most capable of writing it. It established a general design for the work and a truly high plane of scientific competence. The plan is that of a complete manual, with introductory pages on morphology and biology. The taxonomic portion includes keys to all groups down to species, and under each of the latter the synonymy, an adequate description, the distribution (accompanied by precise records) the ethology and the subspecies (if any) are dealt with. Illustrations delineating differentiating characters are numerous, and there are complete illustrations of the principal types, so that from these alone one may gain some idea of the variations of habitus within the fauna.

The last volume to appear, just issued, is Part I of the "Coléoptères carabiques de la région malgache," by René Jeannel. It follows two volumes in the *Faune de France* by the same author, dealing with the same group, in which a long-awaited new classification of these beetles has been presented, based in large measure on research concerning the structure of the male genitalia, which was previously disregarded. In the opinion of the reviewer this represents not merely a revolution but a strong advance in our knowledge of the interrelationships of these beetles (although his judgment would question the necessity of assigning family rank to so many subdivisions). It is a matter of moment to entomologists to see this new classification extended in detail to the Caraboidea (in which term Cicindelidae and Paussidae as well as Carabidae are included) of the Malagasy Subregion. Dr. Jeannel accepts the theories of continental drift of Köppen and Wegener, and his introductory pages on the origin of the Malagasy faunas, as well as his account of the climate, vegetation, and biogeographical divisions, will be of wide interest.

Intermediate between the first and latest volumes to appear have been one on the Bovidae of French Equatorial Africa (from the Congo to the Sudan and Rio de Oro), by Paul Rode; one on the Scarabaeid beetles of Indo-China, by Renaud Paulian (which, along with his treatment of the Scarabaeidae in the *Faune de France*, is no less worthy of note than the volumes on carabid beetles); one on the birds of Reunion, by Jacques Berlioz; and one on the longicorn beetles of North Africa, by Andre Villiers.

The early appearance is promised of a volume completing the Caraboidea of Madagascar, of one by E. Fletiaux on the Coleoptera of the French Antilles, one by A. Villiers on the reduviid Hemiptera of tropical Africa, and of one dealing with the polychaete annelids of New Caledonia, by P. Fauvel. The 23 volumes in preparation form an exciting list: 12 on insects; 2 each on arachnids, molluscs, and fish; and 1 each on mammals, birds, lizards, ctenophores, and corals. Such a series of manuals of tropical faunas has been previously attempted only in the fauna of British India, but that, of course, deals with only a single area.

The Editorial Committee consists of R. Jeannel, J. Millot, Th. Monod, L. Berland, and L. Chopard, both of the latter being secretaries.

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Scientific Book Register

ADKINS, HOMER. (Ed.-in-Chief.) *Organic syntheses: an annual publication of satisfactory methods for the preparation of organic chemicals.* (Vol. 26.) New York: John Wiley; London: Chapman & Hall, 1946. Pp. iv + 124. (Illustrated.)

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COLIN, EDWARD C. *Elements of genetics: Mendel's laws of heredity with special application to man.* (2nd ed.) Philadelphia-Toronto: Blakiston, 1946. Pp. xiii + 402. (Illustrated.) $3.50.

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CRAIG, SIR JOHN. *Newton at the mint.* Cambridge, Engl.: at the Univ. Press; New York: Macmillan, 1946. Pp. 128. (Illustrated.) $2.50.

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HILL, D. W. *Science: its effect on industry, politics, war, education, religion and leadership.* Brooklyn, N. Y.: Chemical Publishing Co., 1946. Pp. v + 114. $2.75.

HOOTON, EARNEST ALBERT. *Up from the ape.* (Rev. ed.) New York: Macmillan, 1946. Pp. xxi + 788. (Illustrated.) $5.00.

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LEMON, HARVEY BRACE. *From Galileo to the nuclear age: an introduction to physics.* (Rev. ed.) Chicago, Ill.: Univ. Press, 1946. Pp. xviii + 451. (Illustrated.) $3.75, text edition; $5.00, trade edition.

MARCHIONNA, FREDERICK. *Butalastic polymers: their preparation and applications. A treatise on synthetic rubbers.* New York: Reinhold, 1946. Pp. vii + 642. (Illustrated.) $8.50.

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TALBERT, THOMAS J. *General horticulture.* Philadelphia: Lea & Febiger, 1946. Pp. 452. (Illustrated.) $4.00.

Financing Cancer Research

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FAILURE OF THE NEELY-PEPPER BILL, calling for an appropriation of $100,000,000 for cancer research, to pass on July 27, 1946 was not the reflection in Congress of any unwillingness on the part of the public to foot the bill. On the contrary, the results of a Gallup Poll, reported on June 12, indicated that 87 per cent of voters were ready to support the Neely-Pepper program and that 72 per cent were even willing to pay extra taxes to provide the money. The bill failed because the experts could not pull together and advise our senators and representatives as to just what is needed. A similar confusion of tongues led to failure of legislation designed to foster scientific research by the establishment and maintenance of a National Science Foundation.

We must profit now by experience and frame a new cancer bill which will pass unanimously. First, it is essential to show, to the satisfaction of cancer experts, how $100,000,000 can be advantageously spent on cancer research with the single purpose of overcoming this disease as quickly as possible. Second, it is equally essential to show, to the satisfaction of Congress, how expenditure of this sum can be properly controlled.

Six objectives are worthy of consideration:

(1) *To expand cancer research facilities throughout the United States.*

At present most of the work is concentrated in the great cities along the Atlantic Seaboard. Except in the state of Missouri, there are no cancer hospitals west of the Mississippi which are recognized by the American College of Surgeons. In a general way the *age-adjusted* death rates from cancer per 100,000 population of the several states are indices of the alertness of the medical profession in the recognition of cancer, not of its actual frequency. According to data published in April 1946 by the National Cancer Institute, the two highest rates are those of New York and Rhode Island, with 144.61 and 138.43 per 100,000; the two lowest are those of Arkansas and New Mexico, with 62.25 and 71.13, respectively. Evidence such as this strongly suggests that citizens in the western and southern states have not an equal chance for cancer diagnosis with those in the eastern ones. California stands out in the Far West with the high rate of 118.43. In the testimony at hearings of the Neely-Pepper Bill the Midwest and Far West were inadequately represented; of a total of 24, only 3 persons from west of the Mississippi were heard, compared with 11 from New York City.

The outstanding cancer research centers of the world are the National Cancer Institute near Washington, D. C., operated by the Government (U. S. Public Health Service), and the Memorial Hospital in New York. They seem a long way off to westerners, some of whom are getting weary of voluntarily contributing fairly large sums, much of which is sent to New York and is expended mostly in the East. It is not surprising that they welcome a proposal that has been presented to the National Advisory Cancer Council of the U. S. Public Health Service, and by Dr. Sherwood Moore in testimony at a hearing of the Neely-Pepper Bill, in accordance with which pilot cancer centers, on a par with the National Cancer Institute and the Memorial Hospital, would be established and maintained in the Middle and Far West. The one for the Middle West should be an expansion of the Barnard Hospital in St. Louis, which for long years has been a pioneer comparable in a small way with Memorial Hospital in New York. St. Louis is a more strategic location than Chicago for this purpose, because the states immediately west and southwest of it are less adequately provided with cancer facilities than Iowa, Wisconsin, and Minnesota, west and northwest of Chicago. St. Louis stands on the border of a very large territory, commercially tributary to it, in which the influence of such a Midwest Center would lead to the development of cancer facilities still more conveniently located. San Francisco is probably better located than Los Angeles for the Far West, or Pacific Cancer Center.

Construction and equipment of each of these strategic centers would cost about $5,000,000. In addition, some expansion of cancer facilities in the East and throughout the United States is urgently needed. The total cost of necessary enlargement of such facilities can be conservatively estimated at about $20,000,000. Since there is urgency in this need for working space for both laboratory and clinical research, high priority should be given to construction of buildings and purchase of equipment.

(2) *To increase the effectiveness of cancer investigators without waiting to train them.*

These individuals are in three categories: (a) Expert clinicians, now busily engaged in treating cancer and patients suffering from other diseases, should be enabled to devote all their energy and skill to the cancer patients. If this could be arranged, it might further be feasible to encourage these clinicians constructively to attack aspects of the cancer problem that can be solved only in the clinic, even in some cases to take time off from practice for this purpose. They cheerfully rallied to the Nation's call in the war. Many of them will be no less ready to attack cancer in times of peace. (b) Persons now working only part time on cancer research should be persuaded to devote full time to such research. I have in mind staff members of universities and medical schools who have proved themselves as productive cancer investigators in the time that they have been able to spare from their other duties. To get at the facts, a survey should be made of these individuals. This would probably show that a large amount of excellent work is at present being done by them, and that this could easily be doubled or trebled if they were to devote all their time and energy to the task. (c) Cancer is a problem peculiar in the fact that so many types of training can be utilized in its solution. Numerous physicists, biochemists, physiologists, pharmacologists, and others, by virtue of experience already mature, are well fitted without delay to play leading roles in this kind of research. Carefully selected individuals in this category might easily be induced to devote a year, or several years, to this inspiring task.

A new attitude toward these and other cancer investigators must prevail. They should not be expected to labor merely for the love of it at the smallest salary they will accept, but should be paid high salaries all along the line. We have witnessed key men in government, who worked for the country during the war at minute salaries, one after another seek employment now that the war emergency is over. Cancer is a very real threat to all of us, and the best brains of the Nation must be harnessed regardless of cost. To be content with second-raters would be to jeopardize the whole campaign against cancer. Yet this will be exactly the tendency of the more conservative of the cancer experts, who will say that so-and-so is best qualified but is beyond our reach.

(3) *To make sustaining grants for cancer research.*

Increases in facilities and personnel are not justified except for investigations that can be organized and sustained over a considerable period. Those of us in the field have often had to content ourselves with annual grants. A lot of good work has been financed in this way, and not infrequently the grants are repeated year after year. But, since there is usually no guarantee of continuing financial support, in all fairness one has to warn prospective members of his staff that they may soon have to seek other jobs. No one would blame a young man, beginning a career of promise, if he chose, instead, an appointment with more security. Older workers, who have proved themselves and have fairly secure positions, are naturally not attracted. In case a young man does gamble with his future and, by virtue of the success of his cancer research, is continued for 10 years or more by a succession of annual grants, he will then find himself with no accumulating annuity payments against eventual retirement, because this measure of protection is never provided in grants for cancer research. Being still young, he may say that he does not care, but we know that he will care later. A reasonable degree of economic security must be given cancer workers, not only in attractive continuing salaries, but also in some effective system of annuity—for instance, 10 per cent of salary paid into the annuity fund by the employer and 5 per cent by the employee.

Obviously, the largest item in the expenditure should be in the nature of sustaining grants for salaries, annuity payments, and operating expenses. These should be made to nonprofit institutions of recognized standing coincident with the above-outlined increases in plant and personnel. The said institutions should be required to invest these sustaining grants in Federal bonds. In size, the grants should be sufficient to carry the projects for 20 years, the recipient institutions expending interest and cashing bonds. This policy would amount to Federal endowment of cancer research. The amount of the expenditure should be about $60,000,000.

Precedent for Federal endowment of research in public institutions is found in the Purnell Act "to authorize the more complete endowment of Agricultural Experiment Stations" (see *Budget of the U. S.*, 1945, p. 230). Unless the policy can be adopted of aiding private institutions on a par with public ones, the idea of bringing all our institutional strength to bear on the cancer problem will be an idle dream. The Department of Agriculture is activated by a pressure group, the farmers of the Nation, and it has achieved wonders. The $60,000,000 to stabilize and maintain certain projects in cancer research on a sound basis for 20 years looks small in comparison with the Agricultural Research Administration general account of $40,313,650 in 1944 and $47,123,140 in 1945—not to mention additional millions for special investigations. We now have a group, known as the "Sponsors of Government Action Against Cancer," which is pressing for action and will not accept "no" for an answer. It is to be expected that within a few years other researches on cancer will similarly require stabilization and that this will be one of the accomplishments of the next $100,000,000 appropriation, with which we are not now concerned.

(4) *To produce special supplies and equipment.*

It frequently happens that cancer research is held up for want of certain chemicals that are hard to obtain. Some of them have to be made for the purpose. Physical apparatus is often required which is not on the market and which manufacturers will not take the trouble to design and produce, because it would not be high priced and would never be wanted in quantity. The best way to remove these obstacles that cause most annoying delay and inhibit research would be to establish and maintain a Central Physiochemical Institute for supplies. Such an organization would help not only by giving advice as to feasibility of implementing the ideas of cancer workers, but also by manufacture and, perhaps, by loaning costly apparatus which is available and the need for which might be only temporary. Moreover, reliance on service by the Institute would be economical, for it would relieve research organizations of the necessity of having their own usually poorly equipped mechanical shops and synthetic chemical laboratories. The Institute might well act as a clearinghouse for distribution of isotopes which are now of such importance. Cost to build and equip the Institute might be in the neighborhood of $2,000,000 plus operating expenses of, say, $500,000 a year for 20 years, making a total of $12,000,000.

(5) *To focus cancer research on the human problem.*

The Committee on Growth of the National Research Council, financed by the American Cancer Society, is wisely approaching the cancer problem on a very broad basis. Anything having to do with growth, even remotely, is included as cancer research because of the bearing it may have on malignant growth. All kinds of living things from plants to man are included, because observations on all forms of life may well afford clues to conditions in man. Very few of the 95 grants made by the Committee through June 15, 1946 and amounting to a total of $623,057 related to cancer of definite types in specified organs or tissues. Several concerned breast cancer in mice; two, leukemia; one, melanoma; one, cancer of the thyroid; two, the Brown-Pearce tumor of rabbits; one, normal and malignant fibroblasts; one, the rabbit papilloma virus; and one, leukemia, Hodgkin's disease, etc. Research specified as dealing with cancer of the uterus, stomach, lungs, and other organs of the body was not included. Yet the basic investigations promoted by the Committee on Growth are all to the good. They should be supported from the proposed $100,000,000 appropriation if the funds collected by the American Cancer Society prove insufficient, and other equally fundamental researches should be initiated.

To supplement this fine general and fundamental program of the Committee by developing a different line of attack, it is proposed, with part of the Federal appropriation, to focus research on specific cancers in man. The physician has to diagnose and treat cancer of the stomach, uterus, skin, brain, lungs, and so on through all parts of the body. Cancer in all locations has some features in common, on which light may be expected from the basic researches referred to; but cancer in each of them must be considered individually because of individual differences in the operation of certain important factors. Thus, exposure to external influences like sunlight, which, in excess, is known to cause cancer, is greatest for the skin and negligible for the brain. Mechanical injury is of consequence in cancer of the breast, testicles, bone, and skin and insignificant with respect to the appearance of cancer of the pancreas and lungs. Conditions of cell life in the several parts of the body are of acknowledged importance in regard to the malignant transformation. Since these conditions are far from uniform, they cannot be ignored but must be purposefully taken into consideration. Some tissues have an abundant blood supply, while others are avascular; some are more under the grip of internal secretions than are others, and the functions performed by each are related to needs for supply and removal of waste. Another consequence of the different functional roles is that the symptoms of early cancer will, to some extent, be dependent on the particular function disturbed by the cancer. Therefore, we have to attack cancer wherever we find it, marshaling all available knowledge of specific conditions in every part.

The system of panels advocated would be specifically for uterine, skin, gastric, and lung cancer, and so on down the list of some 20 or more. Each would have a chairman and a vice-chairman, both usually clinicians and, when feasible, of rather different views and training. For instance, the hematologists heading the panel on leukemia (blood cancer) could well represent quite divergent schools of thought. Also, it would not be difficult to find two leading gynecologists for the panel on uterine cancer who would bring different and supplementary experience to bear on the problem. Two leading dermatologists for the panel on skin cancer would supply more effective coverage than one. The other members of each panel should include a physiologist, a biochemist, a pharmacologist, a radiologist, a cytopathologist, an endocrinologist, a nutritionist, a geneticist, and possibly others, each one particularly qualified by experience to deal with problems of the panel. It would be essential for a considerable number of these other members to be engaged in the experimental study of cancer in the organ represented by the panel. The membership of panels should gradually change to bring in the best talent from the whole Nation.

The defeatist will question the usefulness of such panels, saying that there is no assurance that progress will result from these direct attacks and even implying that, in his judgment, the only worth-while strategy is to concentrate on fundamentals—a nice comforting term—and for the time being to ignore special cases. We agree, as already stated, that work on fundamentals must be not only continued but extended with the aid of the $100,000,000 appropriation. In addition, however, we plead for consideration of the cancers in the very regions of the body where they are death dealing. There is reason to hope for significant advances by some of these panels. Reports to the Nation of no progress with respect to types of cancer from which citizens are dying by the thousands would increase determination to make progress. It is not beyond the bounds of possibility that means may be discovered satisfactorily to treat cancer before we learn all the secrets of its nature. In fact, a specific treatment for the greatest human killer in view of number of deaths—malaria—was discovered before the cause was determined. Means of prevention of scurvy was discovered long before its nature was revealed. Several similar examples can be cited. In my opinion, these regional cancer panels are justified as one major part of the grand strategy of the campaign.

The panels should meet regularly four times a year, twice in the East, once in the Middle West, and once in the Pacific states, a limited number of nonmembers in each region being invited to attend and present their work. This, like the strategic pilot centers, would tend to draw all parts of the country into the effort. At one meeting each year leading cancer investigators from abroad should cooperate. Yearly digests of world literature on cancer in the domain of each panel, together with the most up-to-date possible accounts of prevention, diagnosis, and treatment and a summary of research in progress, should be published and widely circulated.

The cost of this regional panel system is difficult to estimate, but the item for travel would be substantial. It is further proposed to make each participant a per-diem payment, as with medical consultants to the Veterans Administration, and, naturally, to cover cost of a full-time secretary for the chairman of each panel, printing, postage, etc. It might amount to $200,000 a year, or, for 20 years, $4,000,000.

(6) *To promote international cooperation in the war against cancer.*

Clearly, cancer is a world problem, and we, ourselves, can have no monopoly of wisdom. It would be highly desirable to arrange for distinguished foreign cancer specialists to come and work in our laboratories for a year or more. Particular types of cancer research in this country will be benefited, and their own experiments at home will also be advanced thereby. Also, carefully selected American cancer investigators should work in foreign countries under the same proviso of mutual advantage. They should be given not merely travel expenses but an allowance for scientific expenses of their work abroad so that they would not constitute a financial burden on the host institutions. A special American committee, working through the newly formed World Health Organization (*Science*, September 27), should be charged with promotion of this international cooperation, with ability to draw on an appropriation for this purpose of $3,000,000.

CONTROL OF EXPENDITURE

It is a waste of time to suggest any plan for delegating administrative control to any private agency, since Congress will insist on Federal control of Federal expenditures. Within the Federal Government it is obvious that the U. S. Public Health Service is best fitted to act in this capacity. A division of the Service, the National Cancer Institute, with its advisory body of the Nation's outstanding cancer experts, the National Advisory Cancer Council, has been recommending grants for cancer research to both public and private institutions for nearly 10 years under authority of the National Cancer Institute Act. All that is necessary is to strengthen this Council so that it will be able to discharge the greatly increased duties contemplated in the proposed new cancer bill. This can probably be accomplished without any change in organization or operation which would be considered controversial.

The officers of the Council should continue to serve in their present capacities: the Surgeon General of the U. S. Public Health Service as *chairman*, ex officio; the chief of the National Cancer Institute of the U. S. Public Health Service as *secretary*, ex officio; and the *executive director* as an appointed official.

The other members of the Council should be increased in number to nine, and the policy should be adopted of making them still more representative of the whole Nation. This could be accomplished in several ways. Rotation of membership has proved satisfactory. With the increase in number, and with period of service three years, three members should be replaced annually by new appointees recommended by the Council. In order regularly to draw "new blood" into the Council, retiring members should not enjoy the privilege of subsequent reappointment, but the active interest and advice of these retiring members should be retained by appointing them members emeriti of the National Advisory Cancer Council. It is proposed that they should meet regularly once a year in the National Cancer Institute and that matters of consequence should be submitted to them for advice on this occasion and also informally at other times.

Another means of making those engaged in cancer research throughout the land feel that the Council is theirs hinges on both membership and meetings. At present, cancer research is mainly centered in the eastern states. Since it is clearly desirable to encourage people in other parts of the country, also possessed of great resources, to engage in the war on cancer with all their might, it would be a wise policy to begin by recruiting members of the Council from west of the Mississippi in the ratio of one to every three from east of the Mississippi. This would amount to a substantial increase in western representation. By the same token, regular meetings of the Council every two months should be held west of the Mississippi in the same ratio of one to every three east of the Mississippi.

The members of the Council not only should be increased in number but also should be enabled to devote more of their time and energy to this service which can mean so much to the people of the United States and of all lands. Though willing and eager to serve without recompense, each of the 12 members of the Council should receive a yearly salary of $5,000 in addition to travel expenses. Moreover, failure from whatever cause to attend two consecutive regular meetings of the Council should be construed as resignation from membership. To operate effectively the Council would require adequate full-time assistance of experts, but the total administrative cost should not exceed 1 per cent of the whole appropriation, namely, $1,000,000.

It is essential that the Council have power to recommend grants for construction of cancer facilities and for expenses of research over periods not to exceed 20 years. Expenditure of all grants by recipient institutions should be audited in accordance with the usual procedure of the U. S. Public Health Service. In selecting projects to be aided, the Council should have complete discretion. The expenditures outlined earlier are, of course, merely suggestions to indicate that $100,000,000 is needed for disbursement in the first 5 years. More will probably be required, and the administrative machinery outlined is intended to carry on for 20 years with the aid of subsequent appropriations establishing other lines of cancer research on an equally firm financial basis.

It would save time and avoid confusion and embarrassment if the Council were to take the initiative—that is, not merely to wait for the shower of high-pressure applications certain to be received if such a cancer bill is passed by Congress but, instead, actively to investigate needs and to invite and assist cancer research institutions considered worthy to formulate projects. No applications for financial aid not originally solicited by the Council should be accepted.

There is a chance that a bill along these lines would go down in history as marking a new era in human welfare in which all-out financial support is provided by government, not for war or for any commercial advantage, but to solve a definite problem in medicine. It is fitting that cancer should be the first disease so attacked. The public is of one mind in this matter. If the experts raise their sights and organize research with skill and wisdom on a large scale, and the policy is adopted of subsidy of long-term projects wherever it is most advantageous throughout the United States, the results will justify many times this expenditure, and the precedent will have been set for a similar approach to other devastating human diseases. Indeed, such a bill would signalize a new kind of emancipation—one of freeing the people from what is believed to be needless suffering and from untimely death.

Scientific Development of the Use of Human Resources:

Progress in the Army Air Forces

John C. Flanagan, ***Colonel,***
Army Air Forces, Washington, D. C.

THERE ARE FEW WHO WOULD QUESTION the fact that by far the most important of the resources available to us are human talents. It is also true that there are few areas in which so little progress has been made in the observation and classification of facts and the establishment of verifiable general laws as in the study of human resources and their utilization. This paper will attempt to show that a science can be developed regarding the use of human resources. Some of the recent findings resulting from the increased activity during the war years will be presented primarily to illustrate the types of research and experimentation which can be expected to be productive of results of practical significance.

The general field in which further research and experimentation is proposed includes the more accurate description of the individual in terms of his aptitudes, basic interests, temperament, and potentialities; the training and education of this individual with such methods and materials as to enable him to make maximum use of his personal endowment; his guidance into the types of vocational and avocational activities which will be of greatest assistance to him in his further development; and evaluation of his success in the activities in which he participates.

In this field certain laws and principles were established by psychologists a number of years back. These relate especially to such matters as learning, forgetting, perception, and motivation. More recently, individual differences and trait differences and their implications for participation in various types of activities have been the subjects of extensive investigation. Scientific research on these matters requires very large groups of individuals, and some of the problems also necessitate waiting several years before final evaluation can be made. In most situations the extent of control of the individuals taking part in an experiment is also quite limited.

In many respects the military situation during wartime is ideal for this type of research. Large numbers are readily available. The life cycle from the time of individual analysis and classification, through training, and on to performing the job for which the individual was selected and trained is compressed into a period of only two or three years. Furthermore, the necessities of war give military authorities a much greater degree of control of the individual with public approval than would ordinarily be possible.

Having the resources of this large laboratory to work with, including the availability, for the staff, of a large

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number of the best psychologists in the country, it has been possible to make important contributions to this branch of scientific knowledge in spite of the pressure to obtain immediately useful practical results in the military situation.

One of the most fundamental tests of the value of a body of knowledge including relationships is the ability to predict events on the basis of information already available. In working with human beings it is much more difficult to obtain full knowledge of all of the large number of relevant factors. In practical situations it is usually desirable to predict from a few relevant items known to represent an oversimplification and only partial coverage. Under these circumstances, the predictions must necessarily be in terms of probabilities which are far less than perfect. Such predictions, however, may be of very great value in certain practical situations.

The higher the pilot stanine, the greater the chances of success in primary pilot training

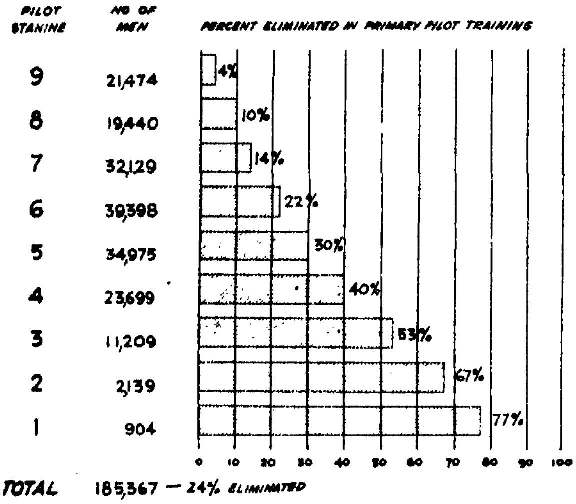

Fig. 1. The bars indicate the proportions eliminated at each pilot stanine. Elimination was for flying deficiency, fear, and own request. Flying experience credit is included in the stanine score. The data are from classes 43-F through 45-H. Men with low stanine scores are now disqualified for training; most of the men with low stanines included in the chart entered primary schools early in 1943.

The original research problem assigned to psychologists in the AAF for scientific investigation early in the period of the recent national emergency was to predict, on the basis of an evaluation of individuals before they begin flying training, which of them would later prove to be the most successful as airplane pilots. As the result of an initial analysis of the requirements of the job and a continuous program of research and follow-up, it was possible to assign weighted aptitude scores ranging from 1 to 9, for the designation of which the term *stanines* (standard nines) was coined. These were based on a battery of 6 apparatus tests of coordination and speed of decision and 14 printed tests including intellectual aptitudes and abilities, perception and visualization, and temperament and motivation. The weighted aptitude scores obtained from these tests were of great value in the selection and classification of applicants for pilot training throughout the recent war period.

Fig. 1 shows the experience during the war in the follow-up in primary pilot training schools of 185,000 men assigned these scores. It will be noted that of the more than 20,000 men obtaining the highest stanine (9) only 4 per cent were eliminated from training. Men obtaining lower stanines had progressively larger proportions eliminated, right on down to the group of about 1,000 men with the lowest stanine (1), 77 per cent of whom were eliminated in primary flying training.

Men with low pilot aptitude scores (stanines) on the AAF aircrew classification tests are very poor prospects for pilot training

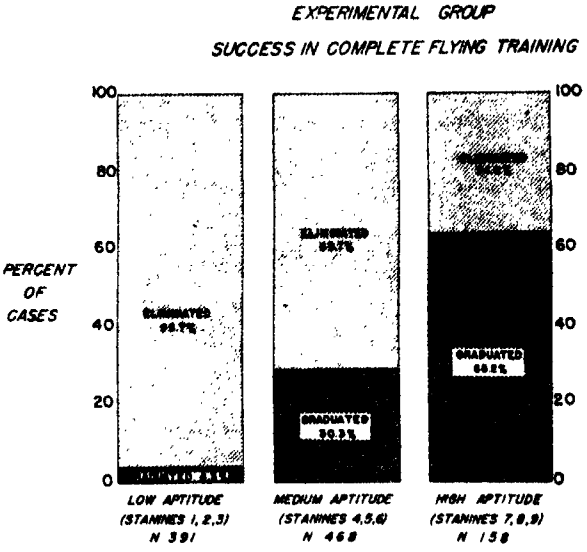

Fig. 2. Results for the experimental group.

Qualifying standards in terms of stanine scores were raised successively until, in the fall of 1944, only men with stanines of 7, 8, and 9 were admitted to pilot training. This improvement in the aptitude level of those sent into flying training made possible the raising of training standards and also resulted in the requirement of a higher degree of flying skill and general proficiency for graduation from flying schools.

In order to provide a comprehensive evaluation of the selection procedures under the new training conditions, an experiment was initiated in the summer of 1943. A sample of more than 1,000 men was selected by representative AAF Examining Boards throughout the country. All of the usual tests of aptitude, ability, temperament, and coordination were given to this group, but regardless of their scores on these tests, all those who met the physical standards of the medical examination were accepted and sent into pilot training. The scores for the various aptitude tests were combined according to current procedures, and the men were assigned the usual stanine scores for pilot aptitude. However, these records were sent directly to Headquarters of the AAF

Training Command, and no indication as to whether the man had obtained a high or low stanine was made available to the training schools.

The results of this experiment are shown in Fig. 2. Members of the experimental group were scattered in various schools and received their flying training in classes graduating in 1944 and 1945. Only 4 per cent of the men with low aptitude (stanine of 1, 2, or 3) were able to complete the full course of flying training. The remaining 96 per cent were eliminated at some stage of their training. Not one of the 125 men with the lowest aptitude score (1) was successful in flying training. Of the men with medium aptitude, 30 per cent were graduated. The men with stanines of 7, 8, and 9, which has been the qualifying standard since the fall of 1944, had a graduation rate of 65 per cent under the new standards in effect in flying training classes in 1944 and 1945. It is clear from these data that very important improvements in training efficiency resulted from the use of these objective selection procedures.

The pilot stanine was effective in predicting success in pilot training for West Point Cadets

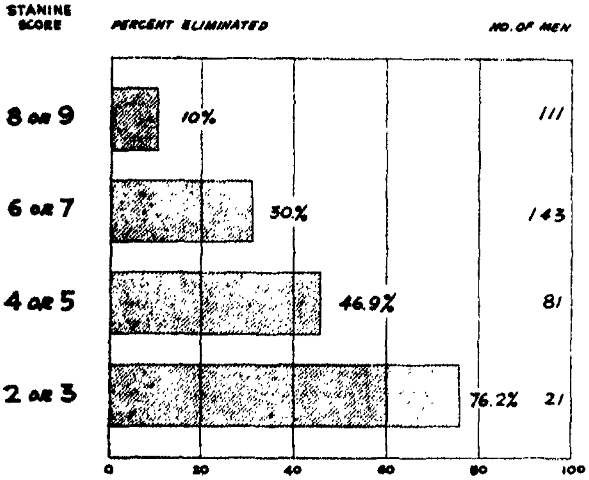

FIG. 3. Results for West Point Cadets.

To check these findings with a group which had been carefully selected, but on other bases than pilot aptitude, an experimental study was made of the class of 1946 at the U. S. Military Academy at West Point. Here again, as shown in Fig. 3, the pilot stanine predicted success in flying training. Only 10 per cent of the 8's and 9's were eliminated, while almost half of the 4's and 5's and more than three-fourths of the small number of cadets whose scores placed them in the lowest group (those with 2's and 3's) were eliminated in primary flying training.

Follow-ups in regard to accident rates, success in transitioning to combat-type planes, and selection as airplane commanders rather than copilots confirm the predictive value of the pilot stanine. For example, 50 per cent more of the fighter pilots receiving combat training in the First Air Force with pilot stanines of 7, 8, and 9 scored in the top half of the class in hits on aerial and ground targets than did men with pilot stanines of 5 and below (see Fig. 4).

The initial emphasis in the psychological research program in the AAF was on pilot *selection*. However, this emphasis shifted rapidly in the practical situation to one of *classification*. Superior pilots are not of great value for bombing operations unless they are accompanied by superior navigators, bombardiers, flight engineers, radar observers, and gunners. Fortunately, it was found that the aptitudes and traits most important for each type of duty differ in various respects, so that by making an accurate analysis of each individual's potentialities in relation to the requirements of the various jobs, it is possible to improve the quality of the personnel available for all positions.

High stanine pilots were likely to score more hits on aerial and ground targets

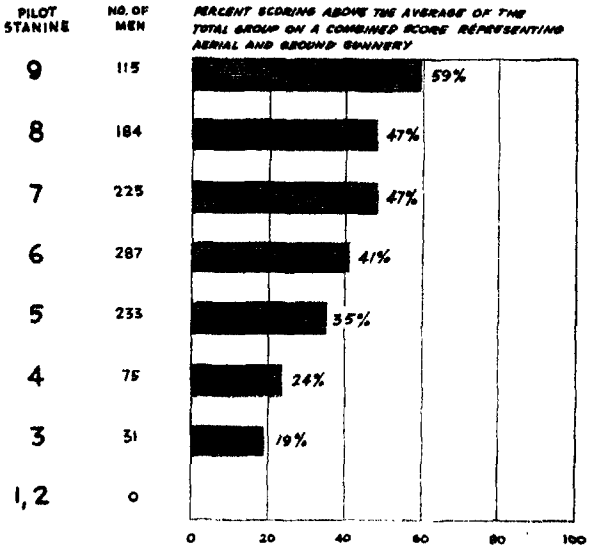

FIG. 4. Data collected from stations and commitments in the 1st Fighter Command between June 1944 and March 1945. Only newly rated pilots are included.

This is illustrated in Fig. 5, which shows the relation of the navigator aptitude score to success in navigation training for approximately 15,500 men. The men with navigator stanines of 8 and 9 were remarkably successful, with only 8 per cent and 3 per cent, respectively, failing to graduate. It is of great importance to the general problem of the use of human resources to note that most of these men had *pilot* stanines of only 6 and 7, and many of them were as low as 3, 4, and 5.

For bombardiers there was, in addition to the usual training school studies, an opportunity to follow up the actual combat results of these men in terms of the distance their bombs fell from the assigned enemy target. The radial or circular errors of 1,300 bombardiers were obtained from photographs taken at the moment of impact of the bombs and compared with the bombardier aptitude scores achieved by these men when they took the Aircrew Classification Tests prior to training, approximately two years earlier. These results are shown in Fig. 6. Although the differences are small, when it is remembered that combat conditions are far from standardized and many factors such as the skill of other members of the crew, weather conditions, the strength of enemy opposition, and the condition of the plane's equipment tend to attenuate the relations observed, the finding of a difference of 100 feet in the average accuracy of bombardiers with bombardier stanines of 7, 8, and 9, as contrasted with those with bombardier stanines of 5 and below, is of great practical significance. The group is also large enough so that this relationship cannot reasonably be regarded as due to chance.

The higher the navigator stanine, the greater the chance of success in advanced navigator training

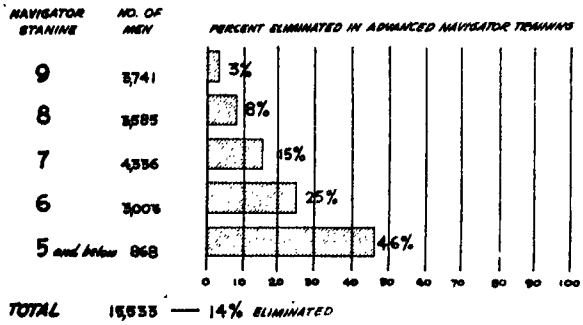

Fig. 5. The bars indicate the proportions eliminated at each navigator stanine. Elimination was for flying deficiency, fear, and own request. Only new aviation cadets are included. These data are from classes 43-12, 43-13, 43-14, 43-17, 43-18, and 44-1 through 45-13.

The illustrations given above with regard to selection and classification indicate results achieved with respect to one aspect of the work of the Aviation Psychology Program. Similar results were achieved in the improvement of certain aspects of training and in the evaluation of success by applying the same scientific methods to problems in these areas.

In developing the battery of tests, the general procedure was to make a systematic survey and exploration of the requirements for success in the activity. This requires knowledge of basic psychological traits and professional insight and skill in translating the apparently critical requirements for success into testable hypotheses in the form of examining procedures. Experience in the AAF indicates that the most productive procedures for developing tests which will have predictive value involve the standardization of the test situation so that the individual knows exactly what his task is and how failure on specific parts of it will affect his score. It must be possible to make the task very nearly identical for all individuals. This means that, if apparatus tests are used, they must be accurately calibrated to insure comparability of difficulty. Although much ingenuity and judgment is required in setting up the sample of performance which is to constitute the test, the scoring should be as objective and free from the subjective judgment of the scorer as possible. The final result should be expressed in one or more simple numerical scores. Such scores are clearly abstractions and oversimplifications, but they represent data which can be evaluated.

Such tests representing hypotheses regarding the essential elements of a practical situation must be evaluated. The validity or predictive value in specific situations can be easily determined if a measure of success in the activity can be obtained. On the basis of such follow-up data the test can be revised, and the whole process of exploration, hypothesis, experiment, and evaluation repeated in the light of the new findings.

Lead bombardiers with high bombardier stanine tend to have lower average circular errors

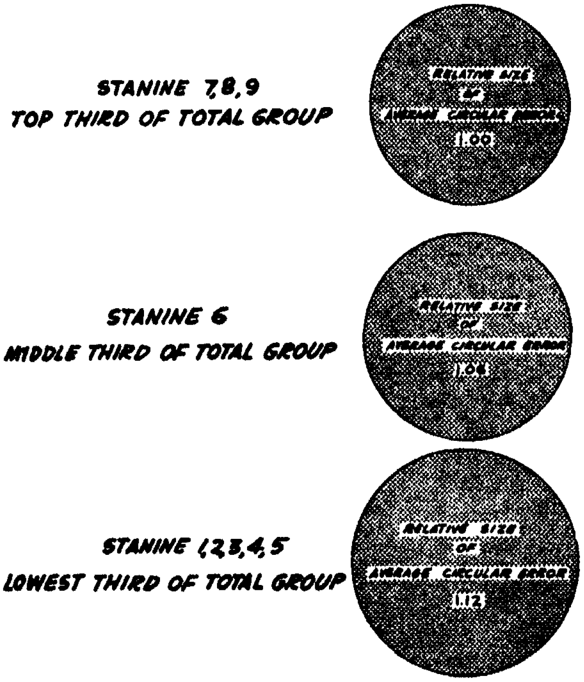
STANINE 7,8,9
TOP THIRD OF TOTAL GROUP
RELATIVE SIZE OF AVERAGE CIRCULAR ERROR
1.00
STANINE 6
MIDDLE THIRD OF TOTAL GROUP
RELATIVE SIZE OF AVERAGE CIRCULAR ERROR
1.04
STANINE 1,2,3,4,5
LOWEST THIRD OF TOTAL GROUP
RELATIVE SIZE OF AVERAGE CIRCULAR ERROR
1.12

Fig. 6. These figures represent a composite of all of the data collected from the 8th and 15th Air Forces on the relation between circular bombing error and the bombardier stanine.

It is believed that the results of the past few years have demonstrated that the application of scientific methods to problems of human resources and their utilization can be of great practical value. Progress has been delayed in the development of this field of knowledge because of the need for large experimental groups, long periods of time, and substantial resources. However, the possible benefits are of great importance from the standpoint both of the general welfare and progress of the country and of the human values involved. It is therefore essential that strong support be given to a coordinated scientific research program on the use of human resources.

NEWS *and Notes*

An additional announcement from AAAS Council through F. R. Moulton, administrative secretary, names the following vice-presidents of the Sections for 1947: Mathematics (A), Robert Lee Moore, University of Texas; Physics (B), Merle A. Tuve, Carnegie Institution of Washington; Chemistry (C), Farrington Daniels, University of Wisconsin; Astronomy (D), Dean B. McLaughlin, University of Michigan; Geology and Geography (E), Marland P. Billings, Harvard University; Zoological Sciences (F), Franz Schrader, Columbia University; Botanical Sciences (G), W. F. Loehwing, University of Iowa; Anthropology (H), Wilson D. Wallis, Heathside Inn, Craftsbury Common, Vermont; Psychology (I), Edna Heidbreder, Wellesley College; Social and Economic Sciences (K), Frederick Stephan, Cornell University; History and Philosophy of Science (L), F. S. C. Northrop, Yale University; Engineering (M), Gordon M. Fair, Harvard University; Medical Sciences (N), E. V. Cowdry, Washington University Medical School; Agriculture (O), William H. Alderman, University of Minnesota; and Education (Q), W. A. Brownell, Duke University.

Two members of the Executive Committee, elected for terms of four years, were George A. Baitsell and Kirtley F. Mather, according to the announcement which pointed out that the new constitution does not provide for elected members of the Council, although under the old constitution eight members of the Council were elected from the fellows of the Association, two each year for terms of four years. On recommendation of the Executive Committee, the Council voted that the eight members of the Council elected under the old constitution be continued until expiration of their terms.

About People

Mark F. Boyd will retire from the staff of the International Health Division, Rockefeller Foundation, at the end of January after 25 years of service. In 1931 he became director of the Malaria Research Station, Tallahassee, Florida, where he worked with naturally induced malaria.

Howard Lawton Knight, editor in chief of the *Experiment Station Record* of the U. S. Department of Agriculture, retired December 31 after 42 years of continuous service in the Department. He first went with the *Experiment Station Record* in 1906 when he was made assistant editor. He took part in the 1934 revision of *Webster's New International Dictionary*.

Martha C. Gundlach, who has prepared more than 50 indexes for the *Experiment Station Record*, retired at the same time as Mr. Knight.

Aaron Edwin Margulis was recently promoted to professor of bacteriology in the New York Post-Graduate Medical School and Hospital. The appointment, which follows the death of Ward J. MacNeal, carries the titles of executive officer of the Department of Bacteriology and director of the Hospital and Dispensary Services of Bacteriology.

Kenneth A. Norton has been made chief of the recently established Frequency Utilization Research Section of the Central Radio Propagation Laboratory, National Bureau of Standards. Mr. Norton rejoined the Bureau from the War Department where he served during the war as a consultant in radio propagation to the Chief Signal Officer and assistant director of W. L. Everitt's Operational Research Group.

George Tunell, on leave from the Geophysical Laboratory, Carnegie Institution, of Washington, until June 30, 1947, is serving as acting associate professor of mineralogy and metalliferous geology at the California Institute of Technology. The position was formerly occupied by H. J. Fraser, who resigned to become general manager of the Falconbridge Nickel Company.

Cdr. Horace C. Dudley was appointed head of the Biochemical Section, Naval Medical Research Institute, Naval Medical Center, Bethesda, Maryland, on his return to civilian status. During the war Cdr. Dudley served as an ammunition and explosive specialist and, more recently, was officer-in-charge, Naval Explosives Unit, for Operation Crossroads. Before the war Cdr. Dudley was with the National Institute of Health.

Ralph W. Lewis, on sabbatical leave as associate professor of biology from Michigan State College, will be at the California Institute of Technology until July 1, conducting postdoctorate research under the direction of G. W. Beadle.

Albert Milzer, formerly research virologist, Samuel Deutsch Serum Center, has been appointed director of the Department of Bacteriology, Michael Reese Hospital, Chicago.

Gordon L. Walls was made an associate professor of physiological optics in the School of Optometry, University of California, Berkeley, effective January 1. Prior to this time, Dr. Walls was research associate with the Bausch & Lomb Optical Company.

I. Newton Kugelmass has been appointed consultant nutritionist to the Department of Health and the Department of Hospitals, New York City.

Courtland L. Butler, Jr., has been named chief of the Information Division, Technical Command, Edgewood Arsenal. Dr. Butler, previously with the Research and Development Division, Office, Chief Chemical Corps, Washington, has specialized in sugars and their derivatives and chemotherapy of pneumonia.

Robert Davis, Department of Psychiatry, University of Colorado School of Medicine, Denver, has been appointed associate professor of neuropsychiatry, University of Texas Medical Branch, Galveston, and assistant director of the Galveston State Psychopathic Hospital.

Charles S. Bridgman has been promoted from assistant professor to associate professor of physics and astronomy, at Ohio State University.

Thomas Sproston, Jr., formerly Massachusetts State College, has been appointed assistant professor of plant pathology, University of Vermont, and assistant plant pathologist, Vermont Agricultural Experiment Station.

B. E. Dahlgren, chief curator of the Botany Department, Chicago Natural History Museum, retired January 1. He will be succeeded by Theodor Just who joined the staff last August as associate curator. Mr. Dahlgren was a member of the Botany staff since 1909 and chief curator since 1924.

John N. Belkin has been appointed head of the Biology Department of Mohawk College, Utica, one of the Associated Colleges of Upper New York, opened this fall especially for veterans.

Dr. Belkin served 39 months in the U.S. Army, where he worked on malaria control in the Asiatic-Pacific theater, and also was Russian interpreter for Headquarters, Armed Forces Pacific Area Command.

Otto E. Guttentag, on temporary leave of absence from the University of California Medical School, has been appointed Consultant in Medical Education in Germany. His address for communications dealing with problems of medical education in Germany is: Otto E. Guttentag, Higher Education and Teacher Training Section, OMGUS, A.P.O. 742, c/o P.M., New York, New York.

H. Radclyffe Roberts, assistant curator of Insects, and member of the Scientific Council and Board of Trustees of the Academy of Natural Sciences, Philadelphia, has been appointed managing director, it has been announced by Charles M. B. Cadwalader, president. Dr. Roberts, with the Academy for about 20 years, served during the war in the Medical Department of the Army and with Edward S. Ross, California Academy of Sciences, produced the mosquito atlas used by the armed forces in combating malaria. He has collected and made field studies in Africa, New Guinea, the Philippines, Hawaii, Mexico, Trinidad, as well as the United States.

Joseph P. Weinmann, Loyola University School of Dentistry, has been appointed associate professor of histology, University of Illinois College of Dentistry.

Grants and Awards

Scientists of all countries have been invited to compete in the next four years for prizes totaling $40,000, a fund established by the Sugar Research Foundation and administered by the National Science Fund, National Academy of Sciences. Established to stimulate scientific studies of sugar as a food and industrial raw material, awards of $5,000 will be given in 1947, 1948, and 1949, with a grand prize of $25,000 in 1950 for the most significant discovery of the preceding five years, Harlow Shapley, chairman of the National Science Fund announced. Winners of the preliminary awards are also eligible for the grand prize.

In discussing rules governing the award, Dr. Shapley remarked that 44 projects dealing with physiological, chemical, and industrial aspects of sugar and its derivatives are being sponsored at universities under the direction of Robert C. Hockett, scientific director, Sugar Research Foundation, through grants-in-aid of more than $500,000. The Foundation, supported by sugar producers and processors of the United States, Cuba, Canada, Puerto Rico, and the Dominican Republic, has been engaged since its formation in 1943 in collating and publishing existing information about sugar.

Entries for the 1947 prize must be in the hands of the Executive Secretary of the National Science Fund, National Academy of Sciences, Washington 25, D. C., no later than February 1.

Members of the Advisory Committee in charge of recommendations for the award include: A. Baird Hastings, Harvard University; Charles F.Kettering, General Motors Corp.; Carl S. Marvel, University of Illinois; Edmund W. Sinnott, Yale University; William C. Stadie, University of Pennsylvania; and Vincent du Vigneaud, Cornell University Medical College. The 1946 prize was awarded recently to W. Z. Hassid, H. A. Barker, and M. Doudoroff, University of California, for the enzymatic synthesis of crystalline sucrose.

The Committee on Scientific Research of the American Medical Association has made the following grants for 1947:

Wesley Spink, University of Minnesota, brucellosis; Catharine Macfarlane, Women's Medical College of Pennsylvania, value of periodic pelvic and breast examinations for cancer; L. R. Cerecedo, Fordham University, vitamin B deficiencies in rats and mice; Reuben Mokotoff, Montefiore Hospital, New York, relation to edema of renal clearance in congestive heart failure; James H. Leathem, Rutgers University, antihormones; George Sayers, University of Utah, pituitary adrenocorticotropic activity; Paul F. Hahn, Vanderbilt University, radioactive manganese in Hodgkin's disease, Leukemia, lymphoma; Bernard N. E. Cohn, National Jewish Hospital, Denver, experimental bone tuberculosis; Harold J. Harris, New York, diagnosis and treatment of brucellosis; Rollin A. Daniel, Jr., and F. T. Billings, Vanderbilt University, atabrine in the treatment of tuberculosis; Hans Popper, Cook County Hospital, Chicago, morphology of the liver in relation to function; Frederick H. Howard, Lincoln Hospital, New York, vectocardiographic research; Archie R. Tunturi, University of Oregon, acoustic system of the dog; Hovey Jordan, University of Vermont, project method in the teaching of histology; Rachmiel Levine, Michael Reese Hospital, Chicago, secretion and metabolism of progesterone in threatened abortion; A. M. Lassek, Medical College of South Carolina, degenerative phenomena in the pyramidal tract.

Colleges & Universities

Zoologisches Institut, Universität, Vienna I, Austria, was three-fourths destroyed, but the collection and library are almost completely preserved, according to a letter from Felix Mainx, formerly assistant professor of plant physiology and genetics at the German University of Prague, and now at the Institut. Technical equipment and genetic material were lost, and current literature is lacking. Reprints on genetics and plant physiology sent to the above address would be appreciated, the letter indicates.

B. F. Skinner, professor of psychology, University of Indiana, will be William James Lecturer in Psychology at Harvard University during the fall term of 1947. Prof. Skinner, fifth psychologist to hold the appointment, will discuss the psychological analysis of verbal behavior in a series of 10 weekly lectures. During the period he will also offer a graduate seminar on the principles of behavior.

Previous William James Lecturers in Psychology have been John Dewey, Wolfgang Köhler, Kurt Goldstein, and E. L. Thorndike.

The new Research Division, Department of Student Life, College of the City of New York, is engaged in an intensive study of the effectiveness of entrance examinations, the results of which will be published by Frank K. Shuttleworth, director of the Division.

The University of Minnesota has accepted a gift of $15,000 to establish the Conway MacMillan Memorial Research Fellowship in Botany and has chosen as first recipient of the $1,200 annual award A. Stanley Holt, graduate student at the University of Minnesota working on the evolution of oxygen by chloroplasts in the presence of oxidizing agents. The gift was presented by Charles J. Brand, former student of Prof. MacMillan and for many years active in the U. S. Department of Agriculture and the trade association field. The donor provides that the principal sum and the interest be spent in 15 years.

Prof. MacMillan was for almost 20 years head of the Department of Botany, University of Minnesota, beginning in

1887, and an active teacher, writer, and researcher in his field. In 1899, according to the donor, he originated the idea of popping other grains as popcorn is popped, a process later patented by a colleague, who continued the experimentation.

The research fellowship is available annually to doctoral students in botany who have their Master's degrees from the University of Minnesota or institutions of similar standing. In the terms of the gift, special mention is accorded those from the University of Chile and the Catholic University of Chile.

Instituto de Pesca del Pacifico has been founded at Guaymas, Sonora, Mexico (Apartado Postal No. 34), according to René Núñez, who has begun research there on the biology and fisheries of the Mexican west coast. Señor Núñez studied at Stanford University under a Fish and Wildlife Service fellowship.

Meetings

The American Academy of Oral Pathology will hold its first annual meeting at the Stevens Hotel, Chicago, February 9. The Academy, organized to promote interchange of ideas in oral pathology, advance sound scientific procedures in clinical dentistry, and stimulate research and teaching, was organized by the Registry of Dental and Oral Pathology of the American Dental Association at the Army Institute of Pathology. Applications for membership may be made through the secretary, Lt. Col. Joseph L. Bernier, Army Institute of Pathology, Washington 25, D. C.

More than 40,000 metal scientists, engineers, and executives are expected to attend the fifth Western Metal Congress and Exposition to be held in the two Oakland, California, Civic Auditoriums in the San Francisco-Oakland area for six days beginning March 22.

Sixteen western divisions of the following technical societies are actively cooperating in the activities of the Congress: American Society for Metals, sponsors of the event; American Chemical Society; American Foundrymen's Association; American Industrial Radium and X-Ray Society; American Institute of Mining and Metallurgical Engineers; American Institute of Electrical Engineers; American Society for Testing Materials; American Society of Tool Engineers, Inc.; American Welding Society; Mining Association of California; Northwest Electric Light and Power Association; Pacific Coast Electric Association; Purchasing Agents Association of California, Inc.; Society of Automotive Engineers; Western Oil and Gas Association; and the American Petroleum Institute.

Further information may be obtained from W. H. Eisenman, managing director, W.M.C.E., Hotel Leamington, Oakland, California.

Alpha Epsilon Delta, national honorary premedical fraternity, in cooperation with the University of Louisville will bring together faculty members from more than 100 colleges and universities at a conference on premedical education in Louisville February 21-22. The program, for institutions in Indiana, Illinois, Kentucky, Michigan, and Ohio, will include one session on the basic sciences and another on social sciences and humanities in relation to medical education. Inquiries may be addressed to Dr. Hugh E. Setterfield, School of Medicine, Ohio State University, Columbus 10, Ohio.

The Natural Resources Council of America was organized at Mammoth Cave, Kentucky, October 25-26, "to advance attainment of sound natural resource management in the public interest," according to Howard Zahniser, representing the Wilderness Society. The functions of the Council as set forth in a program adopted unanimously at the October meeting "shall be to effect closer cooperation and coordination of member organizations . . . make available to member organizations scientific data and other information to aid them in intelligent determination of conservation problems."

Organizations represented at the meeting were National Audubon Society, Friends of the Land, Wildlife Management Institute and American Wildlife Foundation, American Nature Association, Ecological Society of America and Limnological Society of America, Izaak Walton League of America, National Wildlife Federation, National Parks Association, and the Wilderness Society.

Elections

The Emory Chapter of Sigma Xi, Emory University, Georgia, has elected the following officers for 1947: Howard M. Phillips, president; James L. Morrison, vice-president; Charles T. Lester, treasurer; A. C. Munyan, custodian; and Robert Lagemann, secretary.

The American Mathematical Society at its annual meeting in Swarthmore, Pennsylvania, December 28, elected Einar Hille, Yale University, president; P. A. Smith, Columbia University, vice-president; J. R. Kline, University of Pennsylvania, secretary; T. R. Hollcraft, Wells College, associate secretary; and B. P. Gill, College of the City of New York, treasurer.

The Genetics Society of America has elected the following officers for 1947: H. J. Muller, president; L. H. Snyder, vice-president; and M. R. Irwin, secretary-treasurer.

Shell Development Research Club, affiliated with Sigma Xi, elected for 1947, Fred H. Stross, chairman; Harold T. Byck, past chairman; Robert G. Larsen, chairman-elect; Bradford P. Geyer, secretary; and T. Kirk Miles, treasurer.

The Botanical Society of Washington, D. C., has elected the following officers for 1947: Harry R. Fulton, president; Eugene A. Hollowell, vice-president; Elmer C. Stevenson, recording secretary; Anna E. Jenkins, corresponding secretary; Wilbur D. McClellan, treasurer; Lee M. Hutchins and Ronald Bamford, counsellors; John A. Stevenson, archivist; and L. Edwin Yocum, representative to the Washington Academy of Sciences.

The U. S. Department of Agriculture announced on November 25 the successful commercial application of its development for making bristles from casein. Louis B. Howard, chief of the Bureau of Agricultural and Industrial Chemistry, stated that research on the new product was initiated four years ago at its Eastern Regional Research Laboratory, Philadelphia, to find a suitable substitute for imported natural bristle. The artificial fiber, developed by Thomas L. McMeekin and associates, attracted the interest of numerous companies, and one of these, The Rubberset Company of Newark, is opening a new factory at Salisbury, Maryland, for the manufacture of casein bristle and brushes, using the process developed by the Department scientists. The artificial bristle is made by extrusion of a mixture of casein and water through a suitable die, after which it is subjected to finishing operations. The final product is round in cross-section and has a black color comparable to that of horsehair or pig bristle. Like other artificial fibers, it can be produced in any length desired and in a range of diameters. Of many possible uses, the bristle is particularly adapted to the construction of paint brushes, since it is resistant to oils and organic solvents.

The National Registry of Rare Chemicals, Armour Research Foundation, 35 West 33rd Street, Chicago 16, Illinois, indicates that the following chemicals are needed: 4-bromomethylazobenzene; 2-hydroxyhexyl aldehyde; 2-hexen-1-ol; pulegone; thujone; tetrabromo-xylene; 1,3-pentanediol; cyclobutadiene; 3-amino-2,4-dimethylbenzoic acid; aluminum borotartrate; indican; stearolic acid; behenolic acid; d-camphor; 1-menthol; carbonyl cyanide; di-o-tolyl zinc; 2,2′,2″-tripyridyl; 1,1,1,2,3-pentachloroisobutane; 1,1,2,3-tetrachloroisobutane. Communications regarding these should be directed to the Registry at the address given above.

Chronica Botanica has recently issued its first monthly newsletter supplement, *Biologia*, designed to report quickly on biological developments of professional and international interest. The format of *Biologia* is based on a copy of the Massachusetts Centinel of 1786. The newsletter, which will carry short items rather than discussions or articles, will be sent to subscribers of *Chronica Botanica* free and is available to others at the rate of $4.00 for two years.

The U. S. Civil Service Examiners, Philadelphia Quartermaster Depot, have announced examination for the position of chemist, salary range $4,902 to $7,102, for duty at the Philadelphia Quartermaster Depot and other agencies in the Third Civil Service Region. Duties of the positions involve chemical research and development. Applicants, who will be rated on the basis of their experience and training, must submit applications to the Executive Secretary, Board of U. S. Civil Service Examiners, 2800 S. 20th Street, Philadelphia 45, Pennsylvania, not later than February 6.

The Chicago Natural History Museum is currently showing "The Incas," an exhibit of 32 large photographs by Frank Scherschel, photographer for *Life*, who spent many weeks in Peru exploring and photographing traces of the Inca civilization. The exhibit, recently displayed at the New York American Museum of Natural History and the Metropolitan Museum of Art, will continue in Chicago through January 19.

The photographs were taken for the most part in the Urubamba Valley and include the ruins of Fort Sacsahuaman, the hillside village of Winay Wayna, explored in 1941, Ollantaytambo, and Machu Picchu. Thirteen of the panels are devoted to Machu Picchu, one of the best preserved of the Inca cities.

Mendel's manuscript, "Versuche über Pflanzen Hybriden," it is reported, was removed from the Natural History Society, Brno, Czechoslovakia, by a German professor at the time of the Russian occupation. The report comes from Herbert C. Hanson, chief, Agricultural Division, UNRRA Mission to Czechoslovakia, who, in communication with Dr. Jaroslav Kříženecký, Zootechnical Research Institute and College of Agriculture, Brno, learned that Otto Richter, German professor who took over the chair of plant physiology in the Masaryk University and assumed charge of the quarters of the Natural History Society, carried Mendel's manuscript about with him in his briefcase. When the Germans evacuated, Richter disappeared and, it is thought, took the manuscript with him to Germany or Vienna. To date, though search has been made, it has not been found.

The manuscript had been at the Natural History Society in Brno since 1910, when it was found by Prof. Hugo Iltis in a wastepaper basket in the library of the Society.

Recent Deaths

Edgar Lee Hewett, 81, archaeologist, died December 31 at Albuquerque, New Mexico, where he was director of the Museum of New Mexico at the time of his death. Since 1906 Dr. Hewitt had been director of American research for the Archaeological Institute of America; since 1907, director of the American School of Archaeology, now the School of American Research, and president of its Executive Board since 1930. Between 1923 and 1930 he took part in expeditions in Palestine, Syria, Arabia, Mesopotamia, Morocco, Algeria, Tunisia, and the Sahara. He also directed excavations in Guatemala and the southwestern United States.

Eugene Charles Rowe, 76, formerly head of the Department of Psychology and Education, Central State Teachers College, Mt. Pleasant, Michigan, died at St. Petersburg, Florida, December 31.

Johann Georg Koenigsberger, 71, professor emeritus, University of Berlin, died December 3 in Freiburg, Breisgau.

Princeton Bicentennial

A conference on the "Problems of Mathematics," one of a series in celebration of the bicentennial of the founding of Princeton University, was held at Princeton December 17–19. There were, in addition to local mathematicians, 76 other participants, 12 of whom came from outside the United States.

The conference was organized in the form of nine round tables on various subjects, with the discussion oriented as far as possible toward formulation of problems for future work. The sessions were as follows: Algebra—chairman, E. Artin; reporter, G. P. Hochschild; discussion leaders, G. Birkhoff, R. Brauer, N. Jacobson; Algebraic Geometry—chairman, S. Lefschetz; reporter, I. S. Cohen; discussion leaders, W. V. D. Hodge, O. Zariski; Differential Geometry—chairman, O. Veblen; reporter, C. B. Allendoerfer; discussion leaders, V. Hlavatý, T. Y. Thomas; Mathematical Logic—chairman, A. Church; reporter, J. C. C. McKinsey; discussion leader, A. Tarski; Topology—chairman, A. W. Tucker; reporter, S. Eilenberg; discussion leaders, H. Hopf, D. Montgomery, N. E. Steenrod, J. H. C. Whitehead; New Fields—chairman, J. von Neumann; reporter, V. Bargmann; discussion leaders, G. C. Evans, F. D. Murnaghan, J. L. Synge, N. Wiener; Mathematical Probability—chairman, S. S. Wilks; reporter, J. W. Tukey; discussion leaders, H. Cramér, J. L. Doob, W. Feller; Analysis—chairman, S. Bochner; reporter, R. P. Boas; discussion leaders, L. V. Ahlfors, E. Hille, M. Riesz, A. Zygmund; Analysis in the Large—chairman, M. Morse; reporter, M. Shiffman; discussion leaders, R. Courant, H. Hopf. It is planned to issue shortly a descriptive pamphlet, and later a more complete monograph, covering the work of the conference. The monograph will contain an extensive list of the problems proposed.

TECHNICAL PAPERS

The Polished Rocks of Cornudas Mountain, New Mexico

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In 1941 (*1*) I presented my recollections and inferences concerning certain polished surfaces I had noticed on the porphyritic rocks of the Hueco and Cornudas Mountains in Texas and New Mexico. Lately I had opportunity to give more than casual attention to the appearance and relation of the polished surfaces to the rocks on which they are found about Cornudas Mountain.

Both Cornudas Mountain and the Hueco Tanks, which lie along the western Texas and New Mexico boundary and are about 35 miles apart, are plugs or laccolithic intrusions injected into Permian strata from the same igneous magma. The rock is a porphyritic syenite composed of potash feldspar with a small amount of plagioclase, and hornblende, amphibole, biotite, and magnetite. Fresh specimens of the rock range in color from a faint pink to a pale gray, depending on the inherent color of the feldspar. Weathering of the rock frees iron from the ferromagnesian minerals, and a coating of hydrous iron is formed over the weathered surface of the rock which imparts to it a dark reddish-brown color and causes the mountain to glisten in the sun like copper-bronze.

The natural rupture of the rock, either by fracture or spalling, produces a roughened, hackly surface. The fracture tends to pass around rather than through the phenocrysts of feldspar. Thus, the feldspars commonly stand out as much as an eighth of an inch or more above the general level of the rock surface. Spotted over this natural roughened surface of the rock are occasionally to be found highly polished areas. These polished surfaces were seen only on the southeast side of Cornudas Mountain and only within a relatively narrow zone where the coarse rock talus at the base of the cliffs meets the detrital apron. Some enormous blocks of rock have fallen from the cliffs and tumbled out to isolated positions on this surrounding and flat-lying detrital apron. Most of these boulders show some evidence of polish.

Often within the center of a polished area covering 5 to 25 square feet of rock there are no irregularities—only a smooth, glassy surface. This highly polished surface grades outward into a normal rough rock surface through a marginal zone wherein the phenocrysts stand out like rounded and polished cameo buttons in a rough, granular, intaglio background. Thus, a gradation in the state of perfection of the polish is displayed. In the marginal zone the projections of the phenocrysts are progressively less rounded off outward, and the depressions have received no polish where the higher protrusions are not well worn down. It is evident that the polish is due to lapping by a flexible medium which was capable of following to some degree the irregularities of the original surface and thus extending the buffing process somewhat into the recessed parts of the surface. Only one agency is likely to have produced such an effect upon these rocks: It is a common habit for grazing animals to choose certain places to scratch their hides. The hides of animals contain oily matter, and this, when combined with the fine dust which animals habitually toss upon themselves, forms an effective abrasive capable of wearing away rock and producing a high polish.

An examination in section of the polished surface shows a thin discoloration band, extending an average of $\frac{1}{50}$ inch in depth, which is apparently due to absorption of animal fat. It is different in appearance from that due to the staining by hydrates of iron. To determine the presence of oil or fat, a piece of the rock having 4 square inches of polished surface was submitted to W. W. Brannock, of the Chemical Laboratory, Geological Survey, for test. The material was treated with carbon bisulfide after being broken into coarse fragments, and the solvent was evaporated in a porcelain dish. For even so small an area of polished surface as that borne by this piece of rock a very sizable spot of honey-yellow oily matter remained on the porcelain dish. A blank test of the carbon bisulfide proved that oily matter had been extracted from the rock. The associated brown stain was also chemically proved to be an iron compound.

Under low-power magnification a shriveled coating of an amber-colored substance was repeatedly observed on the surface of the highly polished feldspar phenocrysts. This material had the appearance of a dried-out oil film, but both flame and heat tests failed to show any expected results. The material proved refractory. Microscopic examination disclosed that it is isotropic and is silica in the form of opal. From these facts it is deduced that the fine silica dust mixed with oily fats was rubbed on the surface of the rocks by animals, and that in the decades, if not centuries, of exposure to the elements since the last animal used the rock for a rubbing post, the silica weathered to opal, and the oil gradually vanished from the surface film. As the oil distilled away in the heat of the sun, the film shrank, and the residuum of opal formed a shriveled and mummified skin on the face of the feldspar phenocrysts.

These few facts seem convincing evidence that the polished surfaces of rock about Cornudas Mountain are of animal origin.

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Vitamin C Content of Mexican Ornamental Plants

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It is known that the leaves or flowers of certain inedible ornamental plants are very rich in vitamin C: 600 mg./100 grams fresh substance in the lily (*1*); more than 10,000 mg./100 grams dry substance in gladioli (*7*); 900 mg./100 grams fresh substance (*5*) or 6,000 mg./100 grams dry substance (*2*) in *Primula officinalis;* and lesser quantities in other flowers (*4, 6*).

TABLE 1

Botanical name	English name	Part of plant	Month gathered	Fresh substance		Total solids (%)	Dry substance	
				Ascorbic acid (mg./100 grams)	Ascorbic acid + dehydroascorbic acid (mg./100 grams)		Ascorbic acid (mg./100 grams)	Ascorbic acid + dehydroascorbic acid (mg./100 grams)
Althaearosea	Hollyhock	Petals	June	64.6	73.3	18.7	344.3	391.9
Bellis perennis	True or English daisy	"	May	37.4	40.4	14.9	251.0	271.1
Bouvardia longiflora		"	June	90.3	91.7	11.5	785.2	797.3
Centaurea Cyanus	Cornflower or bachelor's-button	"	May	79.5	81.2	16.7	476.0	486.2
Dianthus Caryophyllus	White carnation or clove pink	"	April	126.4	131.5	16.0	790.0	821.8
	Red carnation or clove pink	"	"		136.2	15.6		873.0
Gardenia augusta	Gardenia	"	June	49.0	59.4	17.0	288.2	349.4
		Leaves	"	135.5	143.0	34.8	389.3	410.9
Gladiolus byzantinus	Gladiolus, white	Petals	"	118.3	122.0	6.3	1,877.7	1,936.5
		Leaves	"	52.8	55.8	27.9	189.2	200.0
		Stalks	"	134.0	135.2	14.7	911.5	919.7
Hydrangea Hortensia	Hydrangea	Petals	"	36.4	44.2	23.9	152.3	184.9
		Leaves	"	27.3	34.3	13.9	196.4	246.7
Lathyrus odoratus	Sweet pea, white	Petals	May	72.9	74.4	13.6	536.0	547.0
Lilium candidum	Madonna lily	"	"	45.6	50.5	8.4	542.8	601.2
		Leaves	"	53.4	55.3	13.2	404.5	418.9
		Stalks	"	29.7	34.1	15.4	192.8	221.4
Philadelphus mexicanus	Mock-orange	Petals	"	35.7	37.1	12.9	276.7	287.6
Rosa centifolia	Cabbage rose, white	"	"	64.9	75.4	17.4	372.9	433.3
		Leaves	"	11.4	17.1	32.0	35.6	53.4
Rosa fragans	Tea rose	Petals	June	91.2	106.6	17.2	530.2	619.8
Zantedeschia aethiopica	Calla lily	"	April	90.8	97.6	13.4	677.6	728.3
		Leaves	"	109.4	113.0	20.2	541.5	559.4
		Stalks	"	11.1	15.6	6.3	176.2	247.6

The extraction of vitamin C from gladioli has been included in the subject matter of industrial patents (*8*).

As a contribution to the knowledge of the distribution of vitamin C in inedible plants, we have determined its content in ornamental Mexican plants, by the colorimetric method, using 2,6-dichlorophenol indophenol, determining in each case ascorbic acid alone and the total ascorbic acid plus dehydroascorbic acid by the usual method of reduction with H_2S after precipitating with mercuric acetate (*3*).

In each case we have indicated the part of the plant analyzed and the month in which it was collected. We have determined also the per cent of total solids and have recalculated the two values found in each case to the dry basis.

All the plants selected are ornamental flowers common in Mexico, D. F., and were analyzed the same day they were gathered. The results obtained are reported in Table 1.

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Experimental Argyrosis: II. Treatment of Rats Receiving Silver With 2,3-Dimercaptopropanol (BAL)

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In a previous communication (*3*) it has been reported that silver pigment is deposited in the experimental rat in a way essentially similar to that in which it is deposited in man. In view of the efficacy of 2,3-dimercaptopropanol (BAL) in the treatment of poisoning with arsenic (*1, 4*) and mercury (*2*), it appeared desirable to study the effect of this agent on the experimental argyrosis of the rat.

The experiment was carried out on four rats, grouped in pairs and placed on a diet of dog pellets. The first pair received a solution of 1:1,000 silver nitrate in place of drinking water for a period of 456 days. During this time a total amount of 23.2 grams of silver nitrate was consumed by the two animals, or an average of 11.6 grams each. On the 457th day the silver nitrate solution was discontinued and replaced by water. At this time the eyes of both rats were distinctly pigmented, one slightly more so than the other. Eighteen days later the more deeply stained rat was started on treatment with intramuscular BAL. The BAL was given in a 1:50 dilution in cottonseed oil. A total of nine injections was given on alternate days, covering a period of 18 days. Each single dose was 0.2 mM/kg. (10 times the minimal effective dose for the treatment of acute arsenic poisoning in the cat). The other rat was maintained as a control. The treated animal showed a weight loss of 30 grams over the period of therapy, but otherwise appeared healthy. The control animal lost 6 grams. Both animals were sacrificed on the 21st day, at which time the eyes of the treated rat were still darker than those of the control.

On histological examination, the eyes, thyroid, liver, pancreas, spleen, and kidneys contained an apparently identical amount of silver deposit. No lesions were found in either rat.

The second pair of rats received for a period of 514 days a 1:1,000 solution of silver chloride with added sodium thiosulfate (approximately 1:300) in place of drinking water. The total average silver chloride intake for each of the two animals was 12.9 grams. On the 515th day the silver chloride solution was replaced by drinking water. The eyes of the pair were also distinctly pigmented. Eighteen days later the more deeply stained rat was started on BAL therapy. The dose and manner of administration was as described above, with the exception that a total of 18 injections of BAL was given, covering a period of 38 days. The cage mate was kept as a control. During the period of treatment the treated animal lost 25 grams in weight, but otherwise appeared healthy; the control showed a 3-gram gain. On the 42nd day both were sacrificed, at which time the eyes of the treated rat still appeared darker than those of the control.

On histological examination, there were apparently identical amounts of silver deposits in the thyroid, kidneys, eyes, and choroid plexus of each rat. There were no lesions indicating any toxic effect in either rat.

It appears from these observations on a limited number of animals that BAL is incapable of mobilizing silver, which is deposited in the tissues as metallic silver or silver oxide. It seems likely, therefore, that BAL should prove of little or no value in the treatment of argyria in man. It is interesting to note the marked resistance of the rat to poisoning by BAL. No acute symptoms resulted from the injection of 0.2 mM/kg., and there were no chronic effects from the repeated administration of this quantity of BAL.

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The Movement of Substances Through a Two-phased Solution System[1]

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A thermodynamically sound treatment is essential to an understanding of the movement of substances through solutions. Manifestations of flux are common in aqueous biological systems. These phenomena are logically expressed on the basis of the concept of escaping tendency or free energy of a constituent component. Certain fundamentals of the process are presented in the hope that the free-energy concept, as it applies to this movement, will be adopted generally by biologists. The tendencies for movement of water will be discussed first, followed by that of a solute in an aqueous solution system.

WATER MOVEMENT

Pure water possesses an internal energy representing the sum of its internal kinetic and potential energies. At thermodynamic equilibrium, a steady state, the free energy of the water is equal throughout the phase. The free energy or escaping tendency of the water molecules may be modified by the application of certain chemical or physical influences. The addition of a solute to water lowers the free energy of the solvent in the resultant solution. The application of a pressure to water increases its free energy. At thermodynamic equilibrium within a solution consisting of two components, solvent water and a single solute, the free energy of each component is equal throughout the phase. If each component, the water or the constituent solute, is not at thermodynamic equilibrium throughout the phase, it will work itself through the solution toward equality of escaping tendency, in accordance with the difference in free energy. Here, this process is called a flux, the term diffusion being employed where migration is restricted to a response to a difference of concentration or activity of a constituent component in solution within a system.

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[1] Detailed treatises will be printed in *Botanical Review* (1947), comprehending the movement of water and of a solute. In these, references are made to earlier publications pertinent to the subject.

Symbols used are defined as follows: p is an applied pressure, in a given state of the system, necessary to make $\bar{f}$ equal to $\bar{f}^\circ$; p° is an applied pressure, in a reference or standard state of the system; $\bar{f}$ is the partial molal free energy of a constituent component of a solution in a given state; $\bar{f}^\circ$ is the partial molal free energy of a constituent component of a solution in a reference or standard state—here, at infinite dilution; $\bar{v}^\circ$ is the partial molal volume of a constituent component of a solution in a reference or standard state—here, at infinite dilution; F is a specific (volumed) free energy of a constituent component of a solution in a given state; subscripts i and e refer to the separate phases of a two-phased solution system—here, internal and external, respectively; and subscripts (Δf) or $(-\Delta f)$ refer to influences in or on a system, which increase or decrease, respectively, the free energy of a constituent component of a solution from that in a reference or standard state to that in a given state.

In practice, the free energies themselves are not measured, but the *difference* in free energy of the component between that in the given state and that in a reference or standard state is determined. Gauging the pressure difference which would be necessary to adjust the free energy of the water from that in the given state to that in a reference state serves as a measure of the free-energy difference under the two conditions. In dilute solutions, where the free-energy difference of the water is due only to the presence of solute in the solution, these pressures and free energies are equated approximately through the relation,

$$p - p^0 = \frac{-(\bar{f} - \bar{f}^0)}{\bar{v}^0} = F. \qquad (1)$$

Where pressure is imposed on the medium, as a single factor contributing to the free-energy difference of the water, the equation takes the form,

$$-(p - p^0) = \frac{(\bar{f} - \bar{f}^0)}{\bar{v}^0} = F. \qquad (2)$$

The only difference between Equations 1 and 2 is that of algebraic sign. The net effect of those influences which decrease the free energy of water and those which increase the free energy in a single phase may be expressed by the equation,

$$\Sigma F_{(-\Delta f)} - \Sigma F_{(\Delta f)} = \frac{-(\bar{f} - \bar{f}^0)}{\bar{v}^0}. \qquad (3)$$

The pressure which must be applied to make the free energy of water in a given state equal to that in a reference state may be conveniently observed by a two-phased system in which a semipermeable membrane, permeable to the water, is interposed. The difference in pressure which must be applied to the two phases to bring about thermodynamic equilibrium for water across the interposed membrane is a measure of the free-energy difference of the water between the two phases. The specific (volumed) free energy (F), numerically equal to the partial molal free-energy difference divided by the partial molal volume of the water, is likewise a measure of the free-energy difference. Moreover, it expresses the thermodynamic viewpoint of the escaping tendency of the water from one phase to the other in physically measurable dimensions, namely, pressures. These may be converted to dimensions of energy by means of a coefficient, namely, the partial molal volume of the constituent component at infinite dilution of the solution.

It is of interest to know whether water will tend to migrate from one phase (external) to the other (internal) due to a possible difference in free energy of the water, schematically represented by the formula,

$$H_2O \text{ (external)} \xrightarrow{\text{influx}} H_2O \text{ (internal)}. \qquad (4)$$

The measure of the tendency for water to move is given by the difference between the free energy of the water in the internal phase and that in the external phase of the osmoscope, namely, $(\bar{f}_i - \bar{f}_e)$. If this difference is negative in sign, water will tend to migrate inward, as written in the previously cited formula (4). If the quantities $(\bar{f}_i - \bar{f}^0)$ and $(\bar{f}_e - \bar{f}^0)$ are determined, then the difference between these values is $(\bar{f}_i - \bar{f}_e)$.

For a single phase, the net effect of those influences which decrease the free energy of water and those which increase the free energy was given by the relation,

$$\Sigma F_{(-\Delta f)} - \Sigma F_{(\Delta f)} = \frac{-(\bar{f} - \bar{f}^0)}{\bar{v}^0}. \qquad (3)$$

Then, for the two phases, the net influx specific free energy (NIF) is expressed by the equation,

$$(\Sigma F_{(-\Delta f)} - \Sigma F_{(\Delta f)})_i - (\Sigma F_{(-\Delta f)} - \Sigma F_{(\Delta f)})_e = \frac{-(\bar{f}_i - \bar{f}_e)}{\bar{v}^0} = \text{NIF}. \qquad (5)$$

Instead of expressing the specific free energies in groups relating to the two phases, i and e, respectively, they may be rearranged into categories representing the sums of the specific free energies tending to cause the water to move inward (influx, IF) and outward (efflux, EF) across the membrane. The net influx specific free-energy equation for water then becomes

$$\text{NIF} = \Sigma\text{IF} - \Sigma\text{EF} \qquad (6)$$

or, in more detailed form,

$$\text{NIF} = (\Sigma F_{(-\Delta f)i} + \Sigma F_{(\Delta f)e}) - (\Sigma F_{(-\Delta f)e} + \Sigma F_{(\Delta f)i}). \qquad (7)$$

The latter mode of expression has certain advantages when used in connection with graphic presentations of the specific free-energy and volume relations of an osmometer.

SOLUTE MOVEMENT

By similar reasoning it may be shown that the fundamental principles of the tendencies for movement of solute are analogous to those discussed for water. The only differences in application of the general formulas relate specifically to the influence of the solute concentration of a solution on the specific free energy of a component. In the discussion of water movement the specific free energies referred to the solvent component. There, an *increase* in concentration of solute in a solution is accompanied by a corresponding *decrease* of the partial molal free energy of the water within the phase. For solute migration, the specific free energies refer to a constituent solute species in solution. In contrast, therefore, an *increase* in concentration of solute in a solution is accompanied by a corresponding *increase* of the partial molal free energy of the solute within the phase. In other words, the effect of a solute in solution is included here, in $F_{(\Delta f)}$ rather than in

$F_{(-\Delta f)}$ of Equations 3, 5, and 7. In this case, the symbol $\bar{v}^{o}$ refers to the partial molal volume of a constituent solute in solution.

SUMMARY

The tendencies for movement of either solvent or solute in solution through a two-phased system are expressed in terms of specific (volumed) free energies. These are based on the concept of escaping tendency or free energy of a constituent component of a solution. This scheme is particularly useful to the biologist for evaluating the movement of water and solutes into cells or organs.

The Effect of Streptomycin on the Oxygen Uptake of *Eberthella typhosa*[1,2]

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During the course of investigations into the mode of action of streptomycin, it was found that the oxygen uptake of suspensions of washed cells of *Eberthella typhosa* was increased in the presence of streptomycin.

In 1934, Clowes and Krall (*2*) noted that dinitro compounds increased the oxygen uptake of sea urchin eggs, while apparently inhibiting cell division. In 1937, Clifton (*1*) found other substances which appeared to produce similar results in suspensions of bacteria and yeasts. Clifton took the view that such substances, which increased oxygen uptake and also interfered with certain cell functions, exerted their effects by inhibiting normal synthesis of cell components from the available substrate. In addition, he suggested that these substances might also favor oxidation of materials which had already been stored by the cell.

In this investigation oxygen uptake and respiratory quotients were measured in the Barcroft-Warburg apparatus. The phenomena which were observed resembled, at least superficially, those noted by Clowes and Krall and by Clifton. While the Hopkins strain of *E. typhosa* was used throughout most of this work, preliminary studies indicate that the results apply in general to other strains of *E. typhosa*, as well as to some other species of bacteria. With suspensions of the density used in this work it was found that streptomycin in a concentration greater than 500 units/ml. produced a change in oxygen uptake which was readily measurable and reproducible. Since the dry weight of bacteria per milliliter of suspension was approximately 3 mg., such a concentration of streptomycin is not unduly high.

Streptomycin, sufficient to make a final concentration of 1,000 units/ml., was added to a system in which endogenous respiration was proceeding at 37°C. in a phosphate buffer of pH 7.40. The result was an immediate and rather marked increase in the rate of oxygen uptake. After two hours had passed, the rate of uptake decreased until at six hours it was less than that of the controls, in which the rate of uptake remained constant for many hours.

The addition of glucose in a concentration of 0.01 per cent to a similar system also produced, of course, an increased rate of oxygen uptake. By the time that sufficient oxygen had been taken up to account for oxidation of about 65 per cent of the glucose as well as for endogenous oxidation, the rate of uptake had dropped to that of the controls. Further oxygen uptake occurred at this rate for many hours.

During the same time, when streptomycin in a concentration of 1,000 units/ml. was present as well as the glucose, sufficient oxygen was taken up to account for complete substrate oxidation as well as for oxidation due to the presence of a similar concentration of streptomycin in the system, which contained no available substrate. After this had occurred, oxygen uptake continued at a decreasing rate. When six hours had passed, the rate of uptake was less than that of the controls.

The evidence so far obtained indicates that the increase in oxygen uptake in the presence of streptomycin is not explainable on the grounds that the bacteria are bringing about the oxidation of the streptomycin or of impurities in it. Respiratory quotients are apparently increased 25 per cent by the addition of streptomycin to the previously described system, in which glucose is undergoing oxidation. In general, similar effects occur where other simple substrates are oxidized in the presence of streptomycin by the Hopkins strain of *E. typhosa*.

The effect of streptomycin on the oxygen uptake of a streptomycin-resistant variant of the Hopkins strain is of particular interest. This variant was produced by passing a subculture of the Hopkins strain through peptone water and increasing concentrations of streptomycin until it grew well in the presence of 1,100 units of streptomycin/ml. of peptone water. When glucose and streptomycin, the latter in a concentration of 500 units/ml., were both added to a suspension of the variant, the oxygen uptake was actually less than when glucose alone was added. When the streptomycin concentration was increased to 2,000 units/ml. under similar conditions, the oxygen uptake considerably exceeded the uptake which occurred when glucose alone was added.

When 500 units of streptomycin/ml. were added to suspensions of the variant in the absence of available substrate, no significant change in oxygen uptake occurred, but when the streptomycin concentration was increased to 2,000 units/ml., there was a considerable increase in oxygen uptake.

Preliminary studies of the biochemical changes produced in simple substrates by *E. typhosa* in the presence of streptomycin indicate that the presence of the antibiotic stimulates the production of changes which are compatible with the results observed in oxygen uptake studies. The utilization of carbohydrate substrate appears to be more complete and more rapid when streptomycin is present than when it is absent. It was found that streptomycin interfered with many of the commonly used procedures for the identification and quantitative estimation of the by-products of metabolic activity.

The investigation is in progress and will be reported in detail in a subsequent paper.

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[1] The work described in this report was done under a contract, recommended by the Committee on Medical Research, between the office of Scientific Research and Development and the University of Chicago.

[2] The streptomycin was provided by the Office of Scientific Research and Development from supplies assigned by the Committee on Medical Research for experimental investigations recommended by the Committee on Chemotherapeutics and Other Agents, National Research Council.

IN THE LABORATORY

The Assay of New Rich Natural Sources of Ascorbic Acid

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Plant materials which are reported as containing very high concentrations of ascorbic acid include the hips of wild Alberta roses, *Rosa* sp. (1,300–3,500 mg./100 grams of flesh) (*5*); hips of a cultivated rose, *Rosa laxa* (3,000–5,000 mg./100 grams of flesh) (*5, 6*); green English walnuts, *Juglans regia* (2,000–3,000 mg./100 grams) (*8*); a gooseberry found in India and West China, *Phyllanthus Emblica* (920 mg./100 ml. juice) (*2*); and recently there has been reported the finding of 1,000–3,300 mg. of ascorbic acid/100 grams of edible matter in the West Indian cherry, *Malpighia punicifolia* (*1*).

It is well recognized that there exist in some fresh plant materials, notably green walnuts, certain non-vitamin C substances that reduce the dye, 2:6-dichlorophenolindophenol, on titration with which most published values for ascorbic acid in food materials depend. Means for differentiating true vitamin C from such non-vitamin C reductants are also well established (*3, 4, 9*).

We have shown, in the case of rose hips that non-vitamin C reductants, if present at all, are negligible in amount and that the dye titration provides an accurate index of their true ascorbic acid content (*6*). For English walnuts, which, through the kindness of J. R. van Haarlem, of the Horticultural Experiment Station, Vineland, Ontario, we had the opportunity of examining, the case is quite different, as our results in Table 1 show. The values shown for non-vitamin C reductants are based upon the method of Levy (*3*).

TABLE 1
Vitamin C and Non-Vitamin C Dye Reductants in Green Walnuts
(*Juglans regia*)

Tissue assayed	Weight in grams	Total dye reduction (mg. vitamin C/100 grams tissue)	True ascorbic acid (mg./100 grams tissue)	Non-vitamin C reductants (mg./100 grams tissue)	Non-vitamin C reductants (% of total dye reductants)
Whole nut.....	8.5	1,622	1,232	390	24
Whole nut.....	4.2	1,027	638	389	38
Mesocarp......	6.1	2,114	1,830	284	13
Epicarp.......	6.7	1,312	576	736	56
Mesocarp......	4.3	1,055	942	113	11
Mesocarp*.....	1.37	2,065	1,931	134	7
Epicarp*......	2.13	956	578	378	39

* Tissues from the same nut.

Our assays show that the mesocarp contains more ascorbic acid than the epicarp and has a smaller proportion of non-vitamin C reductants. These findings are in accordance with the results of Wokes, *et al.* (*8*). It may also be observed that the percentage of non-vitamin C reductants varies from approximately 5 to 60 per cent of the total titration in the two tissues, and up to nearly 40 per cent in the whole green nut. The highest concentration of vitamin C in the mesocarp is nearly 2,000 mg./100 grams.

The work of Wokes, *et al.* (*7*) would suggest that the proportion of non-vitamin C reductants present in green walnuts decreases with increased maturity.

In view of such circumstances it would seem that values depending solely on the dye titration, reported for ascorbic acid in new food materials, should be accepted with much reservation.

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Autolyzed Brain Tissue as a Means of Facilitating Transmission of Experimental Poliomyelitis[1]

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Most attempts to infect various animals with poliomyelitis monkey-passage strains or infected human tissues failed until Armstrong (*1*) was able to adapt the Lansing strain from monkeys to cotton rats and from the latter to white mice. Since then many unsuccessful attempts to establish other monkey-passage strains in various rodents have been made, although the spreading factor of Duran-Reynals (*2*) and a variety of technics, such as rapid passage, brain trauma, hyperpyrexia, chilling, and use of immature animals, have been employed (*5*). Successful adaptation of a few other monkey-passage strains in cotton rats has been reported by Toomey and Takacs (*8*) and Jungeblut and Sanders (*4*).

In harvesting brains and cords from CFW (Carworth) Swiss mice paralyzed following intracerebral injection with the Lansing strain of poliomyelitis virus for the preparation of stock virus suspensions, we observed that autolyzed brain tissue removed from mice left in their cages for 7 or 8 hours after death appeared to accelerate the incubation period of

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[1] Aided by a grant from the National Foundation for Infantile Paralysis, Inc.

the disease in passage mice. The autolyzed brain tissue suspensions were bacteriologically sterile. Preliminary experiments showed that the same effect could be produced by mixing sterile, autolyzed brain tissue from normal mice with stock virus suspensions. Mice and cotton rats inoculated with autolyzed, normal brain tissue alone remained normal.

For the present studies the autolyzed brain tissues were obtained from CFW normal mice that were killed by trauma and kept at room temperature for about 16 hours. Ether should not be used for killing because it seems to interfere with autolysis. A 10 per cent suspension by weight of autolyzed brain in nutrient broth (Baltimore Biological Company, pH 6.8) was then prepared by grinding in a sterile mortar with alundum and filtered through sterile gauze. The pH of the autolyzed brain suspensions ranged from 6.9 to 7.1. The suspensions were used immediately after preparation or stored overnight in the refrigerator. All autolyzed brain tissues used were bacteriologically sterile. Adjustment of the autolyzed brain suspension to pH 4.0, using the buffer solution recommended by Hammon (*3*), did not alter its effect. The virus suspensions were prepared from the pooled brains and cords of mice paralyzed 2–5 days after inoculation in the same manner as described in a previous publication (*6*).

Combined results of 8 to 10 different experiments with Lansing poliomyelitis virus comparing the incubation period and the LD_{50} titer for CFW Swiss mice, using autolyzed brain suspension, buffered saline pH 4.0, and normal mouse serum diluents mixed with equal parts of 10 per cent virus suspension, are shown in Table 1. Groups of 8 or more mice were employed in each experiment. Control animals inoculated with autolyzed brain alone remained normal, and sections of their brains and cords were negative.

TABLE 1

Material inoculated	No. of mice	LD_{50} titer of virus	Range of incubation period (days)*	Incubation time (days) to produce 50% mortality
Lansing virus + autolyzed brain	154	1×10^{-5}	1–9	3
Lansing virus + buffered saline pH 4.0	76	1×10^{-4}	2–18	7
Lansing virus + normal mouse serum	48	0.5×10^{-3}	3–20	8.5
Autolyzed brain control	48	0	0	0

* Number of days between inoculation and onset of paralysis.

Five hamsters were inoculated intracerebrally (0.05 cc.) with 10 per cent Lansing strain in autolyzed brain diluent. Two became paralyzed after 24 hours, a third on the 2nd day, while the remaining animals were paralyzed on the 3rd and 15th days, respectively. In each instance the virus was successfully transferred to 8 mice and was neutralized by human poliomyelitis convalescent serum known to contain protective antibodies against the Lansing strain. We failed to produce infection in hamsters inoculated repeatedly with mouse-passage Lansing strain suspended in buffered saline pH 4.0 or normal mouse serum, although successful transmission to this species has been reported previously (*7*).

Preliminary results in rhesus monkeys inoculated intracerebrally with a 10 per cent suspension of the BK, Leon, and McK[2] strains of monkey-passage virus and the Lansing mouse-passage strain suspended in autolyzed brain diluent have shown a fulminating infection with rapidly progressing flaccid paralysis and a very short incubation period. Histopathologic studies of the sections of brains and cords of these monkeys showed lesions typical of severe poliomyelitis.

Transfer of monkey-passage Leon strain to CFW Swiss mice. Ten per cent infected cord suspension from the 12th monkey-passage Leon strain[3] of poliomyelitis virus mixed with equal parts of 10 per cent autolyzed brain suspension was inoculated intracerebrally into each of 8 mice. On the 15th day one mouse developed paralysis of both front and hind legs, and the rest remained well. This animal was sacrificed, and its brain and cord suspension mixed with autolyzed brain was passaged to 8 additional mice. Two mice developed complete paralysis on the 13th and 21st day after inoculation, respectively, while the rest remained well. All of 8 mice inoculated with the third-passage virus mixed with autolyzed brain developed paralysis of one or more limbs in from 8 to 32 days. A cotton rat inoculated intracerebrally with the third-passage virus developed flaccid hind leg paralysis on the 17th day. The fourth passage was also made with autolyzed brain diluent, the 8 inoculated mice developing paralysis in from 4 to 17 days. Sections made of the brains and cords of fourth-passage mice showed lesions typical of severe poliomyelitis. The fifth passage was made with virus suspended in buffered saline pH 4.0 and inoculated intracerebrally into 8 mice, a cotton rat, and a rhesus monkey. The mice all developed paralysis in 2 to 9 days. The cotton rat showed paralysis of both fore limbs on the 8th day. The rhesus monkey had a temperature of 104.5°F. on the 5th day, paraplegia of the arms, and a right facial paralysis. On the following day this animal developed a complete quadriplegia and was sacrificed. Lesions typical of severe poliomyelitis were seen in sections of the brain and cord. Virus obtained from this monkey was passaged to a second monkey and 8 mice with positive results. The sixth-passage virus was completely neutralized by 1/100 dilution of human immune serum globulin, while control mice developed paralysis.

In cross-immunity tests mice immunized with three weekly intraperitoneal injections (0.25 cc. each) of 10 per cent active Lansing and Leon mouse-adapted strains and challenged intracerebrally on the 21st day with 10^{-2} dilution of virus were immune to the homologous strain. Lansing-immunized mice were immune to challenge with the Leon strain, but Leon-immunized mice showed no immunity to the Lansing strain.

There is always a hazard that a latent mouse neurotropic virus will be uncovered in attempting to adapt a monkey-passage strain to mice. The subsequent successful transfer to monkey of the fifth mouse passage of the Leon strain and also neutralization in high dilution with human immune serum globulin rules out the possibility of accidental contamination by a recognized spontaneous neurotropic virus in our stock mice. Furthermore, Leon-immunized mice were not immune to inoculation with Theiler's mouse encephalomyelitis virus (FA strain).

Attempts to transfer virus from other monkey-passage

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[2] The BK, Leon, and McK strains were obtained through the courtesy of Dr. John F. Kessel.

[3] Isolated by Dr. John F. Kessel from human autopsy in 1937.

strains and human cases of poliomyelitis to white mice and cotton rats, using autolyzed brain diluent, are now in progress.

Summary. Autolyzed brain tissue diluent shortens the incubation period and facilitates the transfer of poliomyelitis virus to CFW Swiss mice, hamsters, and rhesus monkeys. The Leon monkey-passage strain of poliomyelitis virus was successfully adapted to CFW Swiss mice by means of this technic.

Since this manuscript was submitted we have isolated several strains of poliomyelitis virus from infected human feces and spinal cord in CFW Swiss mice by means of this technic.

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Semiquantitative Determination of Traces of Uranium: A Fluorophotometric Method for Field Use

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The method described below was devised in an attempt to meet a need for a lightweight portable apparatus for determining traces of uranium. Restrictions of portability were such as to eliminate most chemical and physical methods from consideration. The procedure adopted is an adaptation of that employed by Hernegger and Karlik (*1*) and by Hoffmann (*2*), who succeeded in determining quantities of uranium of the order of 1×10^{-4} µg.

The method used by the above-mentioned workers involves spectrophotometric measurement of the brightness of the fluorescence of a sodium fluoride bead containing traces of uranium, presumed to be in solid solution. A successful adaptation of this technique for use in a portable field kit was achieved by substituting a cast disc of more fusible material for the sodium fluoride bead and by employing a simple visual comparator. Certain features of two fluorophotometers constructed and a brief summary of the results obtained appear to be of sufficient interest to warrant publication.

The first fluorophotometer was constructed for laboratory use as follows: A General Electric AH-8 mercury lamp, powered by a constant-voltage transformer, was employed as a source of near-ultraviolet radiation. An aspheric condensing lens of optical glass was used to focus an enlarged image of the lamp on the fluorescent object. Next to the lens were placed glass filters to isolate the 365-mµ line. Corning Glass Works filters Nos. 585 and 986 were found to be satisfactory by spectrographic tests. Light of lower wave length (254 mµ) was found to excite fluorescence other than that due to the uranium-alkali-fluoride system and would also require use of optical materials other than glass. The fluorescent disc, a blank, and a reference disc of canary glass were held in a sliding carriage oriented at 45° to the axis of the illuminating system so as to permit fluorescent and reflected light to enter a Weston Photronic cell oriented at right angles to the illuminating beam. The carriage was constructed of blackened aluminum and served to mask the sometimes irregular edges of the discs. Between the carriage and the cell were placed two filters, which isolated the green fluorescence and prevented ultraviolet and blue light from entering the cell. Corning Glass Works filters Nos. 351 and 428 were employed. The output of the cell was taken through an Ayrton shunt to a sensitive galvanometer (0.001 µA/mm./M). The entire instrument, exclusive of the galvanometer and shunt, was contained in a hardwood box provided with light-tight ventilators. The integral lamp unit was lined with sheet aluminum.

TABLE 1

Relative Fluorescence of NaF-NaCl Discs* Containing Uranium

Added element	Relative fluorescence	Remarks
None	1.0	
Al	0.9	
As	0.9	Disc fragile
B	1.0	
Ba	1.0	
Be	0.9	
Bi	—	Disc fragile and discolored
Br	1.0	
Ca	1.0	
Cb	1.0 (+?)	
Cd	—	Disc adheres to platinum
Ce	0.5	Disc yellowish
Co	0.4	Disc gray
Cr	0.2	Disc pronounced yellow
Cu	0.9	Disc slightly gray
Fe	0.5	Disc yellowish
Hg	0.9	
I	1.0	
Mg	1.0	
Mn	—	Disc blue-green and adheres to Pt
Mo	1.0	
Ni	1.0	
Pb	0.3	Disc fragile and yellowish
Sb	0.3	
Si	1.0	
Sn	1.0	
Sr	1.0	
Ta	1.0	
Th	1.0	
Ti	1.0	
Tl	1.0 (+?)	
V	0.9	
W	0.9	
Zn	0.6	
Zr	1.0	

* The discs contained 35–100 µg. uranium/gram flux and, initially, a threefold excess by weight of added element. Discs were fused 10 minutes at bright red heat and weighed 1.9 grams.

This instrument was used for preliminary studies on the effect of temperature of fusion, composition, and thickness of the alkali fluoride discs, and for subsequent studies on interfering substances. It was found that a mixture of 5.75 parts

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[1] Present address: Metal Hydrides, Inc., Beverly, Massachusetts.

[2] The authors wish to express their thanks to Metal Hydrides, Inc., of Beverly, Massachusetts, for financial assistance which made this work possible

sodium fluoride with 1.00 part sodium chloride was satisfactory in all respects. The mixture fused easily at about 900° C. in a platinum crucible cover over a Bunsen or Mekker burner and, on rapid cooling in contact with a cold metal block, formed a fine-grain disc, easily separable from the platinum and sufficiently durable to withstand ordinary handling. A disc weighing 2 grams and 30 mm. in diameter was found satisfactory. The crucible covers used were shaped on a hardwood die and cleaned prior to each use by repeated fusions with the flux. The fluorescence of uranium-containing discs was increased by heating at bright red heat for 7 minutes, but decreased on more prolonged heating. Interference by several of the substances listed in Table 1 was reduced by heating, maximum fluorescence being attained in most cases in from 7 to 10 minutes.

Under the conditions cited, the fluorescence of the discs, as measured by the galvanometer deflections, showed a nearly linear relation to the uranium content over the range 0.2–50.0 μg. uranium/gram flux. At higher concentrations of uranium, up to 300 μg./gram flux, a smooth curve was obtained. (The maximum reported by Nichols and Slattery (*3*) is found at much higher concentrations.) The curves were used directly as working curves, by standardizing the instrument with a uranium glass disc at frequent intervals and making the occasional slight correction required by the blank. This type of instrument is capable of very great sensitivity, although the accuracy might be considerably improved by substitution of a phototube balanced circuit for the single barrier-layer cell.

It was required that the second fluorophotometer be portable, light, and able to withstand rough handling. Since great accuracy was not essential, an exceedingly simple type of visual comparator was used. This consisted of a comparator wheel on which were mounted standard alkali fluoride discs and a holder for the disc to be examined. The concentration of uranium in the standard discs varied geometrically from 0.1 to 200 μg./gram flux. The source of ultraviolet was a General Electric 4-watt RP-12 lamp, which may be operated from a 24-volt battery through a variable 25-ohm resistance. This lamp radiates principally in the vicinity of 365 mμ and is far more effective than the common 110-volt argon glow lamp. A Corning Glass Works filter No. 584 was used to eliminate practically all visible light. The instrument, including batteries, was housed in a specially designed plywood case measuring 6 x 7 x 10 inches (Fig. 1). The weight was only 4.8 pounds. The method of preparing discs for use in the portable comparator is similar to that mentioned above, except that, in field use, a gasoline blowtorch is used, and necessary weighings are accomplished with a portable balance. Sampling is more time consuming than the actual analysis, which requires 20 minutes at the most.

Because of the requirements imposed, standard techniques for the chemical separation of uranium from samples were not considered feasible. Under ordinary conditions, the method of Hoffmann (*2*) is satisfactory but tedious. A semi-quantitative study of the effect of relatively large amounts of impurities was undertaken and is recorded in Table 1. Of the substances studied, antimony, bismuth, cadmium, cerium, cobalt, chromium, iron, lead, manganese, and zinc were found to interfere seriously, because they quench the fluorescence due to uranium, obscure it by coloring the flux, or render the disc brittle. Northup (*4*), in a recent article, gives a more extended discussion of substances which interfere qualitatively with the fluorescence of sodium fluoride beads, together with a study of the effect of columbium, the one element which shows fluorescence similar to that due to uranium.

Several possible procedures for inactivating or volatilizing the above-mentioned impurities were tried. It might be expected that many of these elements could be volatilized as the halide by heating with ammonium chloride, hydrofluoric acid, etc. This procedure was fairly successful with iron, but in all cases significant amounts of uranium were lost. Attempts to volatilize chromium as chromyl chloride were unsuccessful for the same reason. Dilution of the sample with flux did not greatly alter the extent of interference, except that fragility was decreased.

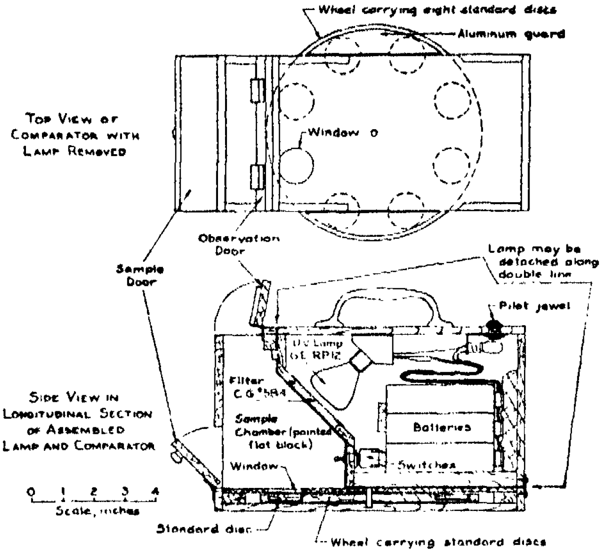
Wheel carrying eight standard discs
Aluminum guard
Top View of Comparator with Lamp Removed
Window 0
Observation Door
Sample Door
Lamp may be detached along double line
Pilot jewel
UV Lamp GE RP12
Filter C.G.°584
Side View in Longitudinal Section of Assembled Lamp and Comparator
Sample Chamber (painted flat block)
Batteries
Window
Switches
0 1 2 3 4
Scale, inches
Standard disc
Wheel carrying standard discs

FIG. 1

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A Simple Resistance Thermometer for Blood-Temperature Measurements[1]

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In connection with an instrumentation program for the Medical Research Laboratory, Edgewood Arsenal, a compact field instrument has been developed for the intravenous measurement of animal blood temperature in the vicinity of the heart. The instrument, a resistance thermometer, is compact, easily constructed, fast responding (5 seconds), accurate, and rugged.

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[1] This work was carried out under contract with the Medical Division of the Chemical Warfare Service and was under the direction of A. H. Pfund. The authors wish to thank Capt. Lawrence Hobson (MC), AUS, for whom the instrument was constructed, for his suggestions, enthusiastic use of the instrument, and patience. We are indebted to Mr. C. B. Green, of the Bell Telephone Laboratories, for supplying the thermistor elements and pertinent information.

[2] Now with Leeds and Northrup Company, Philadelphia, Pennsylvania.

THE TEMPERATURE-SENSITIVE ELEMENT AND ITS MOUNTING

The temperature-sensitive element is a small, glass-coated, spheroidal thermistor bead (Western Electric V-642) with a resistance of about 1,300 ohms at 36° C. and a temperature coefficient of about −3.5 per cent at this temperature. For insertion into a vein through a 12-gauge hollow needle, the thermistor bead is mounted on the end of a 5-French catheter[a] as shown in Fig. 1.

The thermistor bead fits into a spherical recess in one end of a small copper cylinder, the other end of which is cut down to match the inside diameter of the catheter. The cylinder is 0.070 inches in diameter, ½ inch long, and has a hole (No. 72 drill) bored through its length for the thermistor leads.

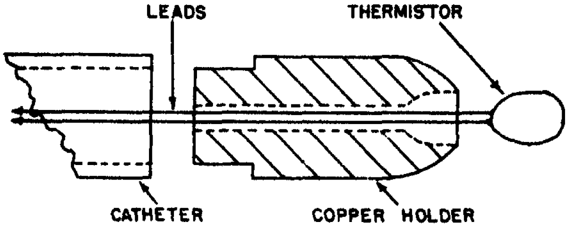

FIG. 1. Thermistor mounting details.

Two-foot lengths of No. 32 gauge enameled copper wire are soldered to the thermistor leads, after which the soldered junctions and the thermistor leads are given a few insulating coats of thinned glyptal varnish. These leads are then threaded through the copper holder and the catheter. The copper holder is cemented into the end of the catheter with glyptal, and the bead is similarly cemented into the recess in the end of the copper. After a few hours this end of the catheter is dipped in thinned glyptal and dried in air. This is repeated until the whole assembly presents a continuous, smooth surface. Heavier copper wires are soldered to the No. 32 gauge leads at the other end of the catheter, the junctions varnished, and the wires and catheter tightly taped together. Only two leads are used because the relatively high resistance change of the element with temperature makes compensating leads unnecessary.

ASSOCIATED ELECTRICAL CIRCUIT

The circuit which translates thermistor resistance values into temperature is a conventional Wheatstone network with the thermistor in one arm. The bridge is balanced for a thermistor temperature of 46.0°, and other temperatures are read as unbalance. Since the indicating meter is a zero center meter, and the unbalance is linear for thermistor temperatures within a 10° C. range on either side of 46.0° C., the thermometer indicates temperature linearly from 36.0° C. to 56.0° C. The scale is marked off in 0.2° C. divisions and can easily be read to 0.1 ° C.

The complete electrical circuit is shown in Fig. 2. Two controls (*A*, *B*) are provided: *B* permits adjustment of the balancing resistance, and *A*, limited adjustment of the bridge potential. In order to avoid temperature errors due to heating of the element by the bridge current, a maximum of 3 volts is applied to the bridge. The bridge meter (*M*) is a Triplett Model 625 microammeter (1,000 ohms) set on the 100-0-100 microampere scale. A double throw switch allows the temperature-indicating meter to be used in standardizing the bridge voltage. The switch cuts the meter out of the bridge and puts it in series with a fixed resistance and the bridge potential. The switch has three positions (*S*, *R*, *T*). Position *S* uses the meter for bridge-voltage standardization. With the switch in position *T*, *M* indicates the temperature of the thermistor. Position *R* disconnects the meter (*M*) from the circuit for use of auxiliary recording apparatus.

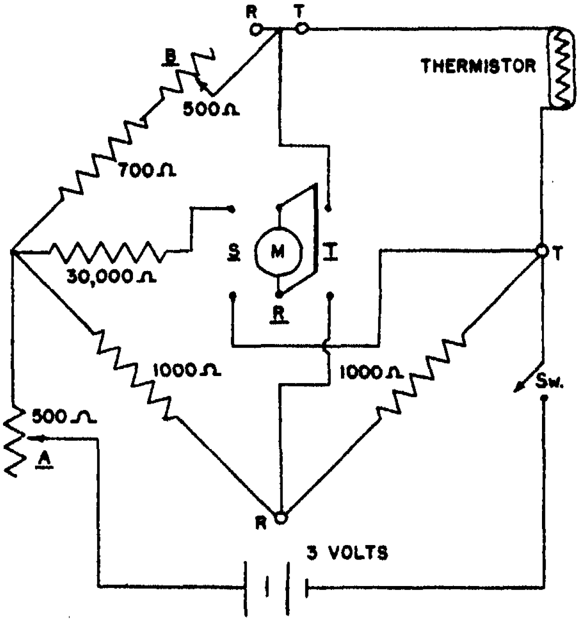

FIG. 2. Bridge circuit diagram.

The most striking instrumental feature of the bridge is the location of all bridge elements, controls, switches, and batteries inside the case of the meter. This Triplett case measures 5½ x 6 x 2½ inches; hence, the complete bridge and meter forms a very compact unit. The zero-adjusting rheostat (*B*) and voltage-standardizing rheostat (*A*) are mounted on one side of the case, and the two switches on the other. The four terminals atop the Triplett case have been rewired as the two terminals marked T and the two marked R on the diagram. The T terminals provide bridge connections for the thermistor, and the R terminals are provided in case it is desired to use auxiliary recording equipment.

After preliminary calibration, the only check that needs to be made on the instrument before use at a later date is a voltage check, which consists of removing the thermistor, snapping the switch to position *S*, and adjusting *A* until the meter gives the standard deflection corresponding to the correct bridge voltage. This deflection is determined by the preliminary calibration. After the voltage check, the thermistor is connected to the bridge, and the instrument is ready for use.

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[a] We have found an excellent source of very inexpensive catheters in Belden 8941 No. 20 solid lead wire with braid-lacquered insulation. The insulation is slipped off a two-foot length of wire, the loose white inside insulation is removed, and the remaining length of waterproof lacquered braid constitutes a catheter. The flexibility of the catheter is ideal for the present application.

Conclusions

Several months' use of this instrument in field work under extreme conditions has proved its ruggedness and ease of handling. It has filled a definite need in the Edgewood work and should be quite useful wherever an accurate, simple, and fast thermometer is necessary in physiological studies. The introduction of another matched temperature-sensitive element in the opposite bridge arm would make this instrument applicable to the measurement of temperature differences.

The Cultivation of Mammalian Liver Cells in Large Numbers[1]

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The cultivation *in vitro* of cells of ectodermal origin may become important in certain investigations, particularly in the application of tissue culture to virus studies, biochemical analyses, and studies of malignancy. However, the cultivation of such cells presents difficulties because of the greater facility of growth of the connective tissue elements present in such explants.

The technic to be described was developed in the course of experiments on the attempted cultivation of the agent of infectious hepatitis. This method made it possible to produce cultures containing large numbers of liver cells with few fibroblasts, without employing a very elaborate technic. The method is based on the roller-tube technic of Gey (*2*), with the following modifications: the random distribution of many pieces of explanted tissue in roller tubes, and the use of a medium which selectively favors the growth of epithelial cells.

Materials

For a typical experiment involving 24 tubes the following sterile materials were required: 24 acid-free and grease-free test tubes, 18 x 150 mm.; a few capillary pipettes about 3 mm. in diameter at the tip; a few capillary pipettes, 200 mm. long, with the usual diameter at the tip (about 1 mm.) and bent at a 45° angle at a point 2–3 mm. from the tip; 24 solid rubber stoppers to fit the culture tubes; 3–50-cc. pointed centrifuge tubes; 1:600 heparin solution; 3–20-cc. bulb pipettes; a Petri plate, 100 mm. in diameter, containing a watch glass; a syringe and needle suitable for withdrawing 20 cc. of heart's blood from a rabbit; and a few dissecting instruments, including one fine, small, curved scissors, preferably strabismus scissors. A small amount of ice and rubber bulbs or tubing for manipulation of the pipettes are also needed.

Assembling the Culture

The explant material was obtained from a rabbit 7–10 days old, lightly anesthetized and exsanguinated. A portion of the liver was removed aseptically and placed in the watch glass contained in the Petri plate. The tissue was minced with strabismus scissors until the bits appeared to be about 1 mm. in diameter. The minced tissue was then suspended in Gey's solution (*2*) in the watch glass and transferred to a 50-cc. centrifuge tube. The top of the Petri plate was used as a shield to prevent contamination from the air. About 20 cc. of Gey's solution were then added to the tissue suspension in the tube. The latter was rotated until the tissue was distributed and was then allowed to stand. After a few minutes all the particles of about 1 mm. had settled below a well-defined plane, leaving a supernate containing erythrocytes and minute fragments. This supernate was removed by suction, and the washing of tissue fragments in Gey's solution was repeated twice more. After the supernate was removed for the third time a wide capillary pipette with rubber bulb was used to distribute small amounts of the sediment into the cotton-plugged culture tubes. The volume of the rather watery sediment which was picked up each time for placing in the culture tubes was such as to contain about 60 pieces of tissue in about 0.3 cc. of the saline solution.

The tissue was distributed by means of the capillary pipettes with bent tips. Throughout the procedure the culture tube was kept horizontal to avoid contamination from the air. The technic of distribution was as follows: The pipette was used to spread the small amount of fluid over the lower half of the tube until the entire surface was moistened, and the clump of fragments was distributed in a rough ring around the tube. Then the point of the bent tip was turned toward the surface of the tube and run up and down between the bottom of the tube and approximately halfway to the open end, while the left hand slowly rotated the tube. Bits of tissue were thus distributed over the entire lower half of the tube. Clumps remaining after this procedure were pushed apart by the tip of the capillary pipette, and any noted gross unevenness of distribution was corrected. Quite often many pairs of tissue fragments were left in contact by this procedure, but since the purpose of the method was to obtain a maximum total circumference of explants in as little time of manipulation as possible, this was not regarded as objectionable. Thus, 60 fragments which included 10 contiguous pairs would reproduce the effect of 50 entirely separate pieces. After the tissue fragments had been placed in all the tubes they were fixed in position by adding to each tube 0.25 cc. of heparinized normal rabbit plasma, which was distributed by rotating the tubes in groups of six in pipette rests until clotting was observed. After nutrient medium had been added to each tube, they were stoppered and placed in a roller-tube mechanism (*1*) rotating at 6 r.p.h.

The plasma was obtained as follows: Sterile 1:600 heparin solution (H.W.D.) was placed in a chilled tube in an ice bath, one-hundredth of the volume of blood to be drawn. Blood was then drawn from a rabbit's heart and quickly placed in the tube. Centrifugation was carried out in ice at 2,000 r.p.m. for 6 minutes, the plasma then being drawn off into another chilled centrifuge tube. This tube, if kept in ice, would not show clotting of the plasma for several hours. Within a few minutes of drawing off, however, the plasma was used to coat the tubes. The heparin concentration was such that the change of temperature from that of the ice bath to room temperature was sufficient to cause clotting. It should be noted that heparinized chicken plasma, where available, may be more convenient, since it remains liquid in the refrigerator for many days and can be coagulated by the addition of hemostatic globulin.

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[1] This investigation was conducted under the Commission on Measles and Mumps, Army Epidemiological Board, Preventive Medicine Service, Office of the Surgeon General, U. S. Army.

The setting up of such a set of 24 tubes required two hours at most, from the anesthetizing of the rabbit to the placing of the tubes in the roller. This involved the work of two people and included the collection and separation of heart's blood for plasma. Bacteriologic aseptic technic was rigorously followed throughout. The rate of contamination was less than one tube per 24.

THE MEDIUM

The development of a satisfactory medium for the selective stimulation of epithelial cells was the major problem of this study. After exhaustive comparisons of salt solutions, relative amounts of serum, effect of embryonic extract, and optimum frequency of refeeding of cultures, the following medium was found to give the best results:

Balanced salt solution was made up according to Gey (*2*) except for the addition of aspartic acid, which Parshley and Sims (*3*) had found stimulating to epithelial cells of skin and thyroid when used in conjunction with Sims' salt solution. Since the addition of aspartic acid and its subsequent neutralization increased the total concentration of salt in the medium, a corresponding adjustment in the amount of NaCl was decided on by calculation. The final salt solution, identical with Gey's except for the amounts of NaOH and NaCl and the addition of aspartic acid, was made up by weighing out and dissolving (in the order shown) in double-distilled water to a final volume of 1 l. the following salts: NaCl, 8.0 grams; KCl, 0.375 gram; $CaCl_2$, 0.275 gram; $NaHCO_3$, 0.25 gram; $MgCl_2 \cdot 6\ H_2O$, 0.21 gram; Na_2HPO_4, 0.12 gram; KH_2PO_4, 0.025 gram; dextrose, 1.0 gram; and aspartic acid, 3.0 grams. Carbon dioxide was then bubbled through the solution for several minutes. NaOH was added in N/10 concentration until the pH was 7.0. The solution was sterilized by filtration through a Seitz filter. The medium as used consisted of 40 per cent of normal rabbit serum and 60 per cent of the salt solution. It was placed in the 18 x 150-mm. culture tubes in amounts of 1.6 cc. per tube, and the roller was sufficiently elevated at one end to prevent contact of the medium with the rubber stopper. Twice a week the medium was withdrawn and replaced with a similar amount of fresh medium. Once a week, between withdrawal of nutrient fluid and an addition of fresh medium, the clotting procedure was repeated in order to patch the plasma coat.

THE GROWTH OF LIVER CELLS

In the case of the great majority of rabbits used, the first outgrowths of liver cells from the explants could be observed in 48 hours in many fragments. In three days there were partial collars of liver cells about most of the fragments. The cells grew out radially in a rather regular form involving columns two cells wide; these would frequently curve and give off branching columns in a Y-configuration. After a few days the growth was usually such that the identity of the columns of cells was lost, and by mutual pressure the growth would form a single, continuous sheet of polygonal cells. Since the explants were often only a few millimeters apart, there was frequent contact between outgrowing sheets of cells arising from different explants. At such points of contact, growth would stop.

In more isolated explants, growth would continue until, after 10–12 days, the 1-mm. explant would be surrounded, in many cases, by collars of outgrowth 3–4 mm. wide, so that the entire sheet of cells formed an approximate circle 7–8 mm. in diameter. Thereafter, growth became markedly slower, and after the 14th day almost no extension in growth was noted. No increase in granularity of cytoplasm was observed until this time, even in the cells nearest the explant. Cultures were not maintained after the 21st day. The cells were large and polygonal, forming a continuous sheet. The nuclei were large, oval, and optically empty in the unstained preparation, with sharp borders except during mitosis. When the preparations were fixed and stained in situ, the nuclei and nucleoli were deeply stained with hematoxylin and the cytoplasm with eosin.

Not all explants, even in the best cultures, showed growth. However, so many fragments of tissue were seeded that the total area of outgrowth was considerable. Taking 3 mm. as an average of the width of the collar of outgrowth around the 1-mm. explant, we find that the sheet of liver cells from one such explant exceeded 30 $mm.^2$ in area. Twenty-five such explants would provide 7 $cm.^2$ of liver cells, and 33, about 10 $cm.^2$ The majority of the successful tubes ranged between these two estimates. This qualification is made advisedly, because at irregular intervals either a liver would fail to grow out at all or the growth would be quite limited and short lived. For this reason, when infectious material was being studied, the cultures were originally fed with the medium described, and the infectious material was added at the time of the second feeding, after three days, at which time it was possible to predict rather accurately the course of that set of cultures. In the case of rabbits whose livers did not demonstrate good growth at that time, the infectious material was stored in the frozen state until a successful culture reached its first refeeding.

Fibroblasts were found in small numbers in almost all tubes. They occurred singly, or in small groups, between explants of liver cells. In all the tubes in which the liver cells multiplied satisfactorily the fibroblasts were very few in comparison. They were more in evidence in those in which some manipulation of the medium had interfered with the outgrowth of liver cells. In such cases there was an increase in the absolute number of those cells.

In a few tubes no fibroblasts could be found. This cannot be taken to mean that a pure culture of liver cells existed in such tubes, but the appearance of the solid sheets of liver cells, often with no other cell type in the vicinity, makes it seem possible that a pure liver culture might be derived from such explants in daughter tubes.

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Book Reviews

Electrical engineering: essential theory and typical applications. Fred H. Pumphrey. New York: Prentice-Hall, 1946. Pp. xiv + 369. (Illustrated.) $5.35.

This is a textbook in electrical engineering for students specializing in other fields. The wide range of topics treated in the volume makes it impossible for all of them to be covered in sufficient detail for the beginner, and the reader will find that many phenomena are not adequately explained. However, the bibliography at the end of each chapter is well selected and will help to solve this difficulty.

The limited material included in the chapters on direct-current machinery and circuits and alternating-current machinery and circuits is well chosen.

The relatively large space given to electron tubes and circuits is amply justified by the great importance of the electron tube as a control device in all branches of electrical engineering. The three short chapters, covering a total of 45 pages, give one of the most satisfactory introductions to the theory of electron tubes and circuits which it has been this reviewer's privilege to see.

The applications of electric energy for heating and welding and in a number of electrochemical processes are covered in a very interesting and informative manner.

In the chapter on electric motor applications the various types of loads are discussed, and the characteristics of the available motors are compared to enable the engineer to make the most satisfactory selection.

Throughout the book the drawings are particularly well made and leave no uncertainty in the mind of the reader. The photographs of details of apparatus are uniformly clear and easily understood.

This is a valuable book for the electrical engineer as well as for engineers in other branches who must make use of electricity as motive power or for control of manufacturing processes.

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Atomic and free radical reactions: the kinetics of gas-phase reactions involving atoms and organic radicals. E. W. R. Steacie. New York: Reinhold, 1946. Pp. vii + 548. $8.00.

"Information concerning elementary reactions is widely spread through the literature of chemical kinetics, photochemistry, pyrolysis, etc., and it is usually very difficult to assemble the existing data on any given reaction. This book is an attempt to bring together such data, and to treat the reactions of atoms and radicals in their own right, rather than as an incidental part of the mechanism of more complex changes." The discussion is confined to elementary reactions involving organic substances.

The book is divided into two parts. After a brief introductory chapter dealing with the elementary theory of reaction rates there are four chapters of a general character. Chapter 2 deals very fully with experimental methods (about 60 pp.). This is followed by three chapters dealing, respectively, with thermal decomposition reactions, polymerization reactions, and photochemical reactions. The material in these chapters is classified, to a large extent, according to the compound being studied. The author has given a very full account of the various proposed reaction mechanisms and has freely given his own judgment as to the extent to which the evidence should be considered conclusive in each case. This critical approach on the part of the author will make the book particularly useful to those who are not expert in this field.

The last half of the book (Chaps. 6–14) classifies reactions according to the elements, starting with carbon and hydrogen compounds, and following with chapters on compounds containing oxygen, nitrogen, chlorine, bromine, iodine, sodium, other metals, and sulfur, respectively.

Two notable features of this book are the extensive bibliography and a reaction index which includes activation energies. The latter will make this volume extremely useful in looking up all the free radical mechanisms involving a given free radical.

In the opinion of this reviewer the author is more successful in "bringing together" reactions of a given atom or radical than he is in "treating them in their own right." While it is true that Chapter 3 begins with an excellent discussion of the strength of bonds in organic molecules, little use is made of this when specific reactions are being considered.

Both the presentation of the material by the author and the format are excellent.

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Photography by infrared: its principles and applications. (2nd ed.) Walter Clark. New York: John Wiley; London: Chapman & Hall, 1946. Pp. xvii + 472. (Illustrated.) $6.00.

The pages of this book, written by Dr. Walter Clark, of the Eastman Kodak Research Laboratories, are filled with information on the general principles of photography, photography by the infrared, infrared radiation sources, value of infrared photography for various kinds of investigations, and some of the general characteristics of infrared radiation and its interaction with various materials.

The first chapter gives a general outline of the book, which is followed in the remaining 15 chapters.

In the second chapter the difference between infrared and ordinary photography is discussed. It is pointed out, with many examples, that many substances that are opaque to light are transparent to infrared radiation. Some of the necessary precautions for taking and developing pictures are then outlined, the extra care entailed by the use of infrared radiation being pointed out. There is a very complete discussion of the extension of the sensitivity of the photographic plate to longer and longer wave lengths, giving the various steps by which this has been accomplished. Plates sensitive out to 12,000 A. are now on the market. The present wavelength limit to the sensitivity of photographic materials is at about 13,500 A. Some of the many difficulties that seem to make further progress difficult are pointed out.

There are five methods of photography in the infrared, two direct and three indirect. The first direct method is the sensitive plate; the second makes use of the Herschel effect, which is that exposure to infrared radiation destroys the effect of previous exposures to shorter wave lengths. The first indirect method depends upon the heating and vaporizing of specially prepared materials; the second makes use of the quenching of the phosphorescence of certain phosphors by infrared radiation; and the basis of the third method is the electron image tube. Probably the present-day limit to the photographic recording by infrared is at about 20,000 A.

Sources of infrared radiation, with characteristic data, are well taken care of in Chapter 7.

The next three chapters are devoted to an examination and differentiation of different materials by infrared photography. This material covers textiles, documents, art works, biological specimens, wood, coal, and botanical specimens.

Chapter 11 is devoted, with many illustrations, to infrared photomicrography. The advantages of the use of the longer wave length are many.

The special applications of this kind of photography are given, again with many illustrations. Pictures taken by the radiation from á hot electric iron are shown, as well as those of audiences taken by infrared radiation without the subjects' knowledge.

Advantage can be taken of the different properties of materials to detect camouflage by the use of infrared photography. Chapters 14, 15, and 16 are devoted to the general characteristics of infrared radiation with respect to its penetration of the atmosphere, dust, smoke, haze, and fog. The optical characteristics of materials with respect to infrared radiation differ in many instances from like characteristics for the shorter-wave-length radiation of the visible spectrum.

The book contains a very complete bibliography and index. The only criticism that can be offered is to express regret that the established nomenclature of the American Standards Association has not been followed.

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Biotechnology:

A New Fundamental in the Training of Engineers

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TEACHING AND RESEARCH ON THE human problems of engineering have been inaugurated as fundamental activities in the Department of Engineering, University of California. This program, which represents an effort to develop a biotechnology as a basic discipline in engineering education, embraces those features of human physiology, psychology, and hygiene which are pertinent to engineering practice. Implicit in the plan is the recognition that the conditions and trends of modern life involve in increasing degree the following sociotechnological elements: (1) the interdependence of man and machines, (2) the progressive extension of artificial control of human environment, and (3) the expanding role of the engineer in human affairs. Engineering practice, it is our conviction, will demand a much more precise formulation of human characteristics for its part in the solution of these problems: in short, a biotechnology to take its place with the physical technologies which are the bulwark of engineering training.

In this era of rapid expansion in engineering application of the diverse products of science, there is continuing pressure for the addition of new technical specialties to the already saturated engineering curriculum; consequently, it is clear that any curricular innovation must fully justify itself on practical as well as philosophical grounds. We believe, however, that the time is right for the addition of a biological phase to the technological equipment of the engineer, and here set down the reasons for this development.

THE SUBSTANCE OF A BIOTECHNOLOGY

In many phases of engineering, essential design criteria are based upon human physiological characteristics. Ventilation is in part based on respiratory needs and, jointly with heating and air-conditioning, serves the needs of body-temperature regulation and thermal comfort. Illumination requirements depend fundamentally upon the properties of the visual sense. Indeed, all aspects of environmental control, including also noise abatement, reduction of bacterial, physical, and chemical contamination of the air, and functional aspects of industrial design, take their origin from human needs and tolerances. These elements of environmental hygiene, well recognized in engineering practice as it concerns public and industrial buildings, extend now to the home and to transportation vehicles.

The structure of the human body, both statically and dynamically, is often an important consideration in engineering design. Applied anthropometry finds important utilization in aircraft cabin appointments, machine design, and comfort seating. Recent improvements in amputation prosthesis may be credited to the collaboration of engineer, physican, and limb fitter. Here, the engineer performs invaluable service through application of his knowledge of analytical mechanics and the strength of materials. Similar training and experience is useful in determining structural limitations in the human body relative to design of safety harness, such as is used by the steeplejack and by the military aircraft pilot. These problems point to the need for a systematic structural analysis of the human body, and it is but a short step to incorporate the study of anatomical materials, paralleling instruction in engineering materials.

The capacity, efficiency, and endurance of the human machine in physical labor is the concern of every engineer who assumes administrative duties, and doubly so for the production engineer. These factors underlie the principles of scientific management and time-and-motion analysis. When the additional stresses of environmental temperature, pressure, or anoxia accompany the work, physiological tolerance may be a critical concern. Hours of work, on-the-job feeding, rest periods, etc. are also phases of the physiology of work which form an important part of a comprehensive biotechnology.

Understanding of the principles of human psychology, with special reference to industrial and technological pursuits, is a prime objective of the program. Compton (*1*) points out that the engineer is usually a member of an organization, whether industrial, service, or governmental. Accordingly, the ability to work effectively with others is important to his personal success, as well as to that of the organization to which he belongs. Two-thirds of engineering graduates enter business or industrial careers primarily concerned with production, operations, sales, and management. Indeed, by the age of forty, 60 per cent of engineering graduates find themselves in positions of administrative responsibility. What more striking evidence is needed of the fact that the engineer handles men as well as machines and materials! To implement the need for better training of engineers to assume leadership in practical, on-the-job human relations, the standard phases of psychology, such as motivation, learning, social behavior, perception, and emotion, must be applied to such practical problems as industrial relations, job training, personnel management, and wage and hour policy.

The biotechnical program contributes also to a prominent contemporary aim of the profession, namely, to broaden the base of engineering education to include humanistic-social studies (*3*). These studies, in contrast to physical sciences, mathematics, graphics, and other technics, which constitute the essential core of the curriculum, aim at a better understanding of social, economic, and cultural values, and the development of moral and ethical concepts essential to public welfare. Their importance in the education of the engineer derives from the facts that technological developments exert a profound effect upon modern civilization, and that the engineer occupies an increasingly responsible position in the socioeconomic instrumentalities of this evolution.

In early times the engineer was a surveyor, a builder, or a shop owner. With the advent of the modern industrial structure, with its need for technical invention and control, and technological extensions into the fields of communications, transportation, amusement, and the home, the engineer functions in the management, control, and direction of both process and personnel. He has thus become an important instrument in shaping the social and business economy, and it is to fit him more adequately for this role that the humanistic-social studies are advocated.

BIOTECHNICAL STUDIES AND THE ENGINEERING CURRICULUM

The impartial but critical reader, while granting the necessity for a biotechnology, may yet raise two questions, one fundamental and the other practical: (1) Is it the proper function of the engineering department to sponsor biotechnical studies? (2) Will not the addition of such studies seriously burden the engineering curriculum?

The first, concerning academic sponsorship, may in part be answered in the words of Wickenden (*2*):

> Looking to the future, the schools of engineering can scarcely limit their concern to the mathematical and physical sciences, to problems of design and construction, and to the specific details of engineering economy. Engineering will include in its tools any and all sciences as they become exact enough to yield economically predictable results. Various aspects of biology, especially bacteriology, are being incorporated into the working tools of engineering now, and technical psychology is fast approaching a similar stage of development. To fit new scientific materials into the scheme of engineering education involves more than a mere addition of conventional courses in zoology, physiology, bacteriology, or psychology to the curriculum. The new material needs to be functionalized. A large amount of practical research is still needed to work up biotechnics and psycho-technics into trustworthy tools of engineering.

Thus, biotechnology rightfully falls within the scope of engineering practice, considered in its broadest sense. While the physical sciences have traditionally formed the basis of engineering, and it is the common view (indeed, among most engineers themselves) that engineering deals solely with machines, processes, circuits, and structures, theorists agree that the functions of the engineer should be defined less in terms of conventional fields of application than in terms of the method he employs in solving the technological problems of society. It is, therefore, both logical and practical that a biotechnology should develop within the framework of engineering training and practice.

In part, the study and practice of biotechnology is left to engineering by default of other educational and professional agencies. The elements of human biology are now dispersed among the academic sciences of physiology, psychology, anatomy, biology, and physical anthropology. While the field of human biology has certainly suffered much from lack of an integrated treatment as an academic discipline in its own right, the greater fault lies in the fact that society has not found a place, except for medicine and its related pursuits, for an applied science of human biology. It would be gross injustice to minimize the biotechnological contributions of workers in the established academic sciences, much less the services of the organized professions of industrial medicine, industrial psychology, and safety engineering. Rather, we desire to emphasize the errors of omission, to point out the defects resulting from lack of a formal systematization of biotechnology. These are: (1) the comparative scarcity of manuals, text materials, and other media for diffusing the known and pertinent facts of human biology to properly qualified technical personnel who can apply this information; (2) the existence of substantial gaps in technology, which would disappear with practical research oriented to the needs of a general biotechnology. For example, to the writers' knowledge, there does not exist today a manual of human design standards for engineers; (3) the lack of any recognizable course of training, in the universities or elsewhere, for a general biotechnical specialist, and inadequate appreciation of the benefits which would derive from application of such a specialty. This does not mean that the need does not exist but that biotechnological functions either are being performed by inadequately or narrowly trained individuals or are neglected entirely.

Addition of new courses, such as the biotechnologies, to the engineering curriculum raises a further problem. Many engineering educators maintain that basic engineering training should be accomplished within the four-year baccalaureate program, yet a rapidly expanding array of technologies creates a continuous demand for inclusion of new specialized courses in the curriculum. However, it would be literally impossible to foresee and provide for all the varied careers which engineers ultimately pursue, and the details of final occupational adjustment must be left to on-the-job training. This principle is now supported by industry as well as engineering educators. Graduate engineers who have advanced and specialized technical interests or who elect an academic career in engineering teaching and research are provided for in the graduate program. Thus, we may define undergraduate engineering education as one of "practical fundamentals," set between the extremes of pure science and technological practice. This level is achieved less by simplifying the treatment of scientific material than by careful selection and emphasis of those elements which have practical utility, and which, further, are common to many applications.

In keeping with this plan for general engineering education, we seek to pitch the biotechnical studies on the "practical fundamental" level, avoiding the minutiae of biological science which have no immediate utility, but stressing those features of human biology and psychology pertinent to industry and general engineering practice.

A PLAN FOR BIOTECHNICAL TRAINING

(1) *Fundamental courses.* Basic in the program are two courses which cover the pertinent facts of human biology and the interaction of man with his environment in as concise, quantitative, and practical a fashion as the present status of science permits. The first of these courses, The Dynamics of Human Function and Behavior, deals with the physical structure, thermodynamics, and machinery for the accomplishment of work of the body, and with practical psychology. The second, The Influences of Environment on Man, treats of his interactions with atmospheric, thermal, bacterial, radiational, and chemical aspects of the environment, and also the socioeconomic setting. It may be noted that certain topics are predominantly physical and physiological, others psychological; but in so far as possible, an attempt will be made to avoid the common but regrettable separation of these aspects and to integrate them in the most rational manner possible.

(2) *Applied instruction and research.* The possible ramifications of the biotechnical element throughout engineering research and practice are almost infinite, but it will suffice here to name some of the engineering fields in which the basic human aspect is of significant importance in design and control:

Acoustics
Aeronautics
Architecture
Food technology
Illumination
Industrial design
Production and fabrication
Industrial hygiene
Personnel management
Safety
Sales
Sanitation
Ventilation and air-conditioning

It is our hope that the engineering student, prepared by instruction in the biotechnical courses, may approach these advanced specialties with as fundamental an understanding of the biological factors involved as he would undertake an advanced structural design problem with a background in mechanics and strength of materials. The biotechnical elements will also serve as the foundation for applications in other engineering courses. As examples, the effect of vibration on the human system will be incorporated into dynamics courses, skeletal kinematics and dynamics will underlie the study of certain nonmechanized operations, and the fields of acoustics and illumination will be placed upon psychological and physiological bases as well as the physical basis. Thus it will be sought to interweave the biotechnical material throughout the engineering curriculum.

(3) *Problems and prospects.* Above we have outlined the need and set forth the philosophy and first practical steps. The detailed evolution of the program will depend upon experience with its application. It may be expected that progress in science, on the one hand, and trends in technology, on the other, will alter the instruction in general biotechnology and determine the nature of specialized research and applications. It should be emphasized that our primary objective is to broaden the training of the engineer rather than to inaugurate a new engineering subprofession. It is not contemplated that this training will introduce professional conflict between the engineer and the industrial surgeon, toxicologist, or physiologist, the need for whose specialized services in industry remains unchallenged. Rather, the aim is to produce engineers, well prepared with respect to every technical requirement, but with additional competence for dealing with man whether on the structural-functional level or the humanistic-social level.

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Technological Gains and Their Uses:

A Review of Some Recent Economic Changes

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MORE THAN HALF A CENTURY HAS passed since the U. S. Commissioner of Labor officially reported that the era of rapid industrial advance had ended for the then-civilized world, that the future of the great industrial countries held no such opportunities as had the preceding 50 years for the creation of new tools and the profitable employment of the vast amounts of existing capital. Some new processes of manufacture could be expected, and these would act as an ameliorating influence, but the main task remaining was that of consolidating and utilizing the great technical discoveries of the 19th Century. The fallibility of extrapolated human judgments has perhaps never been more glaringly revealed than it is when we set the accomplishments of the last 50 years against these somber predictions. The economic gains of the United States in the first half of the 20th Century have exceeded those of any period in the history of our country and probably those of any period in the history of any modern industrial economy. Modes of production and industrial organization that were only adumbrated by the industrial arts of the 1890's have been developed to yield extraordinary harvests of economic goods. It is true that we have not used our resources, our equipment, and our skills with steady maximum effectiveness, nor have the ends to which we have devoted our energies always been those that would be sought in a world of peace and good will. But for extended periods we have been able to produce goods at rates and in amounts exceeding any previously recorded.

THE MAGNITUDE OF PROGRESS

The over-all gains of the years 1899–1945 may be defined in terms of national income, corrected to take account of changes in the purchasing power of the dollar, or in terms of physical output.[1] The former measure is the more comprehensive, but the two sets of records may be used as complementary and, in some degree, independent estimates. Conjointly, they indicate a four- to fivefold expansion, from the opening of the century to 1945, of the total stream of goods and services produced in the United States. The population of the country had increased, in the meantime, by 86 per cent. The average real income per capita of the population had been multiplied by two and one-half in less than half a century. This is a staggering gain, when set in contrast to the long periods of stagnation in human history and the slow pace of advance as men have gradually won control over the forces and resources of nature. Here was such an industrial revolution as the world had never known.

It is a notable fact that the gains of these years were not distributed evenly over time. From 1899 to 1914 the gain in real income per capita of the population was at a rate slightly less than 2 per cent a year. During the next 15 years, from 1914 to 1929, the rate of advance was one-third again as great. The 10 years from 1929 to 1939 were a period of retrogression, with real national income per head of the population actually declining. The war years from 1939 to 1945 brought an unprecedented gain, exceeding 6 per cent a year. A substantial part of the added income was used, of course, for purposes of national defense; consumer well-being did not advance at any such rate. But the figure reveals the extraordinary, and in good part unsuspected, potentialities of the industrial machine.

FACTORS CONTRIBUTING TO PROGRESS

What were the conditions that made possible this striking advance? The work input is, of course, a major factor in determining the magnitude of the national output. Estimates of changes from time to time in the total work input must take account of changes in the total number of persons productively employed and in the average length of the working week. Relevant data are reasonably good for manufacturing and mining, less accurate for agriculture, and still less satisfactory for the wide variety of service industries. Over-all estimates based on these data indicate that the volume of work input in the United States in the decade 1919–28 was some 53 per cent greater than in the 10 years preceding 1899 and declined to 44 per cent above the base in the decade 1929-38. Substantial increases in the size of the working force had, in the 1930's, been in part offset by material reductions in the length of the work

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[1] The series utilized are the national income estimates of Simon Kuznets (National Bureau of Economic Research) and of the U. S. Department of Commerce, and the production indexes of the National Bureau of Economic Research.

Vice-presidential address delivered at Boston, December 27, 1946, before Section K, AAAS.

week and by unemployment. The war years brought a sharp increase; the average for the seven years 1939–45 was about 82 per cent above the average for the 1889–98 base.

Actual output had grown much more rapidly than had the volume of work input, for the effectiveness of productive effort had increased sharply. In manufacturing, the gain in productivity between 1899 and 1945 approximated 250 per cent; in agriculture, 100 per cent; in mining, 300 per cent. These figures relate, of course, to the situation at the end of the period in question. In defining average conditions over the whole period we may break up the total national income of the United States for the 47 years from 1899 to 1945 and get a rough but useful indication of the shares attributable to the actual labor input, at pre-existing levels of effectiveness, and to enhanced productivity. In dollars of 1929 purchasing power, the aggregate national income of the United States for these 47 years amounted to about 3,151 billions. The labor input of these years, operating at 1889–98 levels of productivity, would have created an aggregate income of 1,667 billions. The increment due to the increased effectiveness with which our resources were utilized amounted to about 1,484 billions, or 47 per cent of the total. This is an impressive figure. Almost one-half of all the goods and services that have been at our disposal for consumption, for the expansion of our industrial plant, and for war purposes since the turn of the century came into being because of increased efficiency in the use of productive resources. We should think our living meager indeed if we had to relinquish overnight half of the real income now at our disposal, yet half of all we have had since 1899 is an increment due to enhanced productivity.

A major factor contributing to this amazing increase in the effectiveness with which human energy is applied to the satisfaction of material wants was, of course, the extended use of improved technology. This comprehends not only the actual amount of capital equipment but also the quality of capital equipment and the technical knowledge that may enhance productive efficiency without adding to the dollar value of invested capital. In agriculture and animal husbandry new and better strains were developed. Techniques of factory organization were improved. The quality of labor was raised, with higher educational attainments and more general acquaintance with mechanical equipment. The shortening of the work week, while it reduced the work input, contributed to an increase in output per hour worked. These various factors played their roles in the great spurt in industrial efficiency that marked the last half century.

THE USES OF ECONOMIC GAINS

When man masters more effective methods of satisfying his wants, several choices are open to him. He must choose between more economic goods and more leisure. To the extent that he chooses more economic goods, he must choose between physical goods and intangible services, and, within the category of physical goods, between those that minister directly to his wants and instrumental goods that may swell future supplies of consumption goods. Finally, he may by choice or compulsion use his productive resources for the purposes of offensive or defensive war.

The division of economic gains, as between voluntary leisure and more economic goods, may be approximated on the basis of changes in the length of the work week, account being taken of the relation of hours worked to man-hour productivity. The estimates relate to the increments of potential output after 1899, the base year. During the first 40 years of this century a constantly expanding portion of our potential gain in national output was allocated to leisure. By 1929 the part of the gain since 1899 so allocated amounted to some 10 per cent, and by the close of the next decade the figure had advanced to 22 per cent. This was materially reduced during the war, but by 1946 had increased again. Taking account of all economic activities, it is reasonably accurate to say that in 1946 about 15 per cent of the potential increment in economic goods and services was foregone, in order that men might work shorter hours.

I turn now to the portion of our energy and resources that we chose to devote to productive purposes. Parts of this were wasted in war; some parts, squandered through involuntary idleness, never reached fruition; some we devoted to the direct satisfaction of our wants; and others we used to build up our industrial equipment and our homes. Here again, estimates giving the approximate distribution of the potential fruits of our productive resources are useful if we recognize the margins of error involved. Let us first consider how the aggregate for this period was divided.

I have cited the total national income of the 47 years, 1899–1945. This would have been something over 6 per cent greater had there been no unemployment in these years. We thus have a potential national income aggregate for this period of about 3,371 billions of dollars (of 1929 purchasing power), distributed approximately as follows:[3]

	Amount in 1929 dollars (billions)		Distribution (%)	
For consumer goods and services..	2,836		84	
Consumer materials...........		1,878		56
Consumer services.............		958		28
For capital formation (net).......	195		6	
For war consumption............	120		4	
Lost through unemployment......	220		6	
Total.......................	3,371		100	

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[3] These estimates and allocations are based on *National product since 1869* and *National product in wartime*, by Simon Kuznets (National Bureau of Economic Research); *Survey of current business* (U. S. Department of Commerce); and *The economic almanac for 1946–47* (National Industrial Conference Board).

Perhaps the outstanding fact revealed by this summary is that we lost through unemployment and war, together, 10 per cent of the potential real income of these 47 years.[3] Unemployment alone accounted for a loss equal to the combined output of any two of the best years we have had in the last half century, prior to 1941; war wastes (including only actual war consumption and not those parts of governmental war expenditure used to feed and clothe men in the armed forces, or those elements that went into plants and equipment presumably useful for peacetime purposes) accounted for a loss equal to the total output of such a good year as 1942.

Ninety per cent of the potential real income of the 47 years we are surveying was actually realized in goods and services suitable for the direct satisfaction of wants and the expansion of our plant and equipment (residences being here included with equipment), 84 per cent of the total going to the first use—the production of consumer goods and services, and 6 per cent to the second. This division represents a very heavy preponderance indeed of expenditures designed to satisfy immediate wants. The 6 per cent[4] devoted to capital formation falls far short of the corresponding average of 15 per cent for the 30 years from 1869 to 1898. The estimates for the last three decades of the 19th Century are subject to a wider margin of error than are figures for recent years, but the difference far exceeds any possible margin attributable to errors of measurement. Two world wars and a protracted depression cut deeply into the resources that would otherwise have been devoted to plant extension, new machines, public works, and homes. It is quite possible that improvements in the quality of capital goods would, in any case, have reduced somewhat the proportion of national income devoted to capital formation, but the pronounced drop we have noted reflects the economic casualties of a sorely troubled period, as well as possible secular tendencies.

This aggregative view of the division of national product during the past 47 years reveals substantial losses due to involuntary idleness, wasteful consumption in war, heavy emphasis upon the satisfaction of consumer wants, and sharply reduced emphasis upon the extension of our industrial plant, our equipment, and our housing. We may better appraise some aspects of this division if we examine the disposition of the increment of output attributable to advancing productivity.

I have presented above an estimate of approximately 1,500 billions of dollars of 1929 purchasing power as the increment due to productivity gains between 1899 and 1945. To what uses did we put this extraordinary addition to our national output? Since producers and consumers do not themselves distinguish between such an increment and the basic production that would have been achieved without productivity gains, it is impossible to give a definitive answer to this question. However, if we may assume that the maintenance of existing consumption standards constitutes a first claim on the income of subsequent periods—an assumption that is strongly warranted—we may give a reasonable answer. On this assumption we obtain the following division:

Uses of incremental output due to productivity gains (1899-1945)	Amount (in billions of dollars of 1929 purchasing power)	Distribution (%)
For enhancement of living standards (consumer uses)......	1,169	79
For net additions to capital equipment...........	195	13
For war consumption.	120	8

As will be seen, the elevation of living standards through greater day-by-day consumption was the primary use to which the gains of enhanced efficiency were put. The source of the extraordinary gain in living standards in the United States since the turn of the century is to be found in greater productivity of effort, not in an increase in the work input. The varied new products and services that entered into the consumption patterns of American citizens within the last few decades were superimposed upon the elements of earlier consumption; they did not in any essential way replace them. Automobiles, radios, electrical appliances, and a diversity of other new consumer goods constituted, in the main, additions to the components of consumption of 1900. These additions came from the great increment of output that higher productivity made possible. By long-term standards this may not have been the best allocation of our new resources. Some needed improvements of industrial plant were not made; transportation networks were not modernized; archaic conditions persisted in most large cities, in the face of the requirements of the automobile age and the air age; housing was inadequate to the needs of a growing population; slum clearance lagged; and educational facilities fell behind our needs. A wiser people might have made better use of the extraordinary largesse of fortune, but this was our choice.

The advance in well-being over the last half century was not, of course, uniform, or even in its incidence, but there was probably no element in the economy that failed to register substantial gains. The division of these gains among producing and consuming groups cannot be traced in detail here, but it is possible to define some of the chief advances and some of the lags of the last 50 years. Because the record of change is an irregular one, with variations from decade to decade in the rates of gain for different economic groups, the movements will be noted by periods since 1899.

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[3] Potential real income here means the income that would have been realized had we used, productively, the labor force at our disposal. It is actual income plus the amount lost through unemployment and does not include income voluntarily foregone through shortening of working hours.

[4] Net capital formation constituted 6.2 per cent of the aggregate real national income (3,151 billions, in 1929 dollars) of the period 1899–1945. For the 30 years, 1869–98, net capital formation averaged 15 per cent of real national income (see Simon Kuznets. *National product since 1869*).

The years from 1899 to 1914 were marked by substantial but not spectacular advances in productivity. Consumers benefited from a cumulative drop in fabricational costs. Farmers, favored by steadily rising prices for their products, were among the immediate gainers. Salaries and other fixed incomes lagged somewhat in the general price advance. Wage earners participated in the general forward movement but made no differential gains. The share of rent in the national income declined slightly, that of dividends increased, that of interest held constant.

The next 15 years, to 1929, brought a great increase in industrial productivity and added a very large increment to the stream of disposable goods and services. Although farmers reaped large rewards during World War I, they fell behind in the 1920's. This was a period of substantial gains for two main groups in the economy: ownership and management, and industrial wage earners. The fruits of enhanced productivity were more narrowly restricted in their distribution than in the years preceding 1914; factors of production most strategically placed to reap the first benefits realized the greatest relative gains. Lower real costs were not reflected commensurately in final selling prices. It is true that producing and consuming groups in general improved their status in these years. So great were the productivity gains that, after allowing for the dissipations of war, for unsound foreign loans and for the bonanza profits of speculators, a substantial surplus remained to support a broad advance in living standards. But the benefits accruing to the great body of consumers were well below our economic potential. We had not learned fully to utilize, to the general advantage, the great new productive powers at our command.

The 1930's brought further technical improvements and accelerated gains in industrial efficiency, but the productivity increment ceased to expand and, indeed, contracted in these years. Terms of exchange moved again against farmers and in favor of industrial wage earners. Employed workers gained materially in rewards per unit of time worked, but the aggregate amount flowing to wage earners was reduced by wide and persistent unemployment. This was a decade of rich but unrealized potentialities.

The record of the most recent period, dating from the outbreak of war in 1939, is an unfinished story. A great surge of new output expanded the disposal surplus. A large portion of this was devoted to war purposes; a still larger portion went to swell the stream of consumer goods and services. Farmers and other primary producers reaped the first gains; industrial labor followed. Real incomes declined for many professional and salaried groups. The relative shares of dividends, interest, and rent in national income were reduced. The year 1946 is bringing further sharp fluctuations in the distribution of income and is reversing some earlier movements. The share of wages and salaries has fallen while that of dividends and interest has advanced. Certain of the most recent tendencies are in the direction of earlier relations, but the period of observation is too short to support firm conclusions concerning the trends of postwar years.

The history of industrial progress in the United States during the 20th Century is, in summary, one of great gains, but of gains that fell short of potentialities. It is a record of productive resources in part misapplied, with inadequate attention to the maintenance and extension of instruments of production and the more durable instruments of the good life—homes, schools, utilities, and cities adapted to the needs of the modern age. There were improvements in the economic fortunes of all producing and consuming groups, but the advances were uneven and irregular. Farmers and other primary producers, industrial labor, salaried and professional workers, recipients of income from property, in turn, moved ahead and lagged behind. If we set economic rewards against contributions of working time, the most sustained gains have been won by industrial labor. General living standards have risen materially, but gains potential in the great technical advances of the 20th Century have been as yet inadequately realized by the mass of consumers. In part, the gains have been lost through war and unemployment; in part, they have gone to strategically placed groups of primary producers, fabricators, distributors, or wage earners. The one prime method of transmitting the benefits of industrial progress to consumers at large—prompt price reduction commensurate with declines in real costs—has not as yet been adopted as generally or applied as broadly as the necessities of a dynamic industrial system require.

Greater advances than those of the last 50 years impend, and a productivity increment of massive proportions is within our grasp, but this increment can be realized to the full only if it is widely shared. The 1920's and the 1930's—both periods of great technical improvements—provide illuminating examples of productivity gains restricted too narrowly in their incidence. In widely different ways they represent paths we must not follow again. One lesson to be drawn from the records of industrial change in the United States in the 20th Century, with its peaks of extraordinary achievement and its valleys of depression, is that in a modern industrial system diversion of the fruits of advancing productivity to restricted groups brings them only short-lived benefits and curtails the gains accruing to the economy at large. If we are to combine economic progress with a greater measure of industrial stability than we have yet achieved, we must learn this lesson and have the wit to apply it.

Obituary

James Hopwood Jeans
1877–1946

In the death of Sir James Jeans on September 16, 1946, astronomy has lost its last remaining link with the great masters in Newtonian tradition of the 19th Century: Roche, Kelvin, Poincaré, Sir George Darwin and Liapounoff.

James Hopwood Jeans was born at Southport on September 11, 1877. His father, William Tullock Jeans who lived at Tulse Hill, London, was a parliamentary journalist. Jeans went to Merchant Taylors' School from 1890 to 1896. At first he took the classical side, but soon found that the mathematical side suited him better. While at school he also developed an interest in experimental chemistry and had a boy's ambition to be an engineer. He went to Cambridge as a scholar at Trinity College in 1896 and graduated as second Wrangler in 1900. In the following year he was elected both to an Isaac Newton studentship and to a fellowship at Trinity.

In 1905 he was appointed to a chair of applied mathematics at Princeton University (U. S. A.) which he occupied until 1909. In 1910 he returned to England as a Stokes Lecturer in mathematics at Cambridge University, but he soon gave up formal teaching for research. In 1917 he received the Adams Prize for a brilliant essay published as *Problems of cosmogony and stellar dynamics*. At this time he had already published his *The dynamical theory of gases* (1904), *Theoretical mechanics* (1906), *Electricity and magnetism* (1908), and *Report on radiation and the quantum theory* (1914).

He was elected a Fellow of the Royal Society in 1906, was awarded a Royal Medal in 1919, and served as secretary of the Society during 1919–29—a period of great expansion of the Society. He was knighted in 1928 and received the Order of Merit in 1939. Latterly, he had held a professorship of astronomy at the Royal Institution. He was president of the Royal Astronomical Society during 1925–27 and had been awarded its Gold Medal in 1922. From 1923 on he was a research associate of the Mount Wilson Observatory, and was the recipient of honorary doctorates from several universities at home and abroad.

One of Jeans's first scientific writings was a confirmation and rigorous establishment, on classical premises, of the law governing the distribution among the different wave lengths of the energy radiated by a black body which had been stated by Lord Rayleigh in 1900. The basic idea in Jeans's proof was the establishment of the equivalence of the electromagnetic radiation in an enclosure with a set of simple harmonic oscillators—an equivalence which forms the basis of all modern developments in the quantum theory of radiation.

His interest in the theory of radiation and the equipartition of energy between the different degrees of freedom of a classical system in thermal equilibrium led him to re-examine the foundations of statistical mechanics and gas theory; and in *The dynamical theory of gases* (1904) he developed the theory "upon as exact a mathematical basis" as possible. This book, which is much in the spirit of Boltzmann's *Vorlesungen über Gas Theorie*, found acceptance despite its severity, and its 1916, 1921, and 1925 editions were read by successive generations of physicists and mathematicians who looked to it "as an oracle, sometimes difficult to fathom as is the way with oracles" (S. Chapman).

His main love, however, was cosmogony, and it is probable that he will be remembered most for his *Problems of cosmogony and stellar dynamics*. In any event, there can be no doubt that his most massive contributions to science lay in this field.

It has long been known that a rotating incompressible mass under its own gravitation assumed for small angular velocities the form of a spheroid—the "flattened orange" —and that for increasing angular momentum, the ellipticity gradually increases. But when the equatorial diameter is 1.7 times the polar diameter, a new phenomenon begins: the equator ceases to be circular and bulges into an ellipse. At this state the configuration is ellipsoidal. Poincaré discovered that these ellipsoids, when there was no constraint compelling them to remain ellipsoids, developed a furrow around the long axis and became "pear-shaped figures"; but he left the stability of these configurations undiscussed. In 1902 Darwin convinced himself that they were stable, while Liapounoff, in a memoir published in 1905, announced the opposite result. The methods followed by Darwin and Liapounoff were very different, and a decision between their conflicting results was a matter of great cosmological importance. At this time it occurred to Jeans that it would be a valuable illustration of the behavior of a rotating liquid mass if the corresponding two-dimensional problem were fully worked out instead of the "heart-breaking actual problem of three dimensions." Accordingly, he considered a rotating cylinder constrained to remain in a cylindrical form. He showed that, for slow rotation, the cylinder is circular, corresponding to the flattened spheroid in the three-dimensional problem. This is succeeded by an elliptic cylinder and then by the analogue of the pear-shaped figure. The figures of equilibrium were traced much further along this last sequence—so far, indeed, as to show that a furrow was forming which "would deepen into a neck." This made it extremely probable that the pear-shaped figure would end in fission into two detached masses. Jeans, therefore, examined the stability of these pear-shaped cylinders. He was able to solve this problem completely, but, having successfully carried through all the difficult analysis, he was led by a numerical error in the final step to announce a result which was the opposite of that which the investigation had really demonstrated. It was not until 1916 that the mistake was discovered by Jeans himself and the pear-shaped cylinder found to be always unstable. This result would support Liapounoff's result as against Darwin's for the three-dimensional, pear-shaped solids. The latter problem was accordingly reinvestigated by Jeans in his Adams Prize essay, by an entirely new method. This enabled him to locate an error in Darwin's calculation and to confirm Liapounoff, thus resolving an enigma of years.

In his cosmological investigations, Jeans did not restrict himself to the incompressible liquid masses alone. The modifications caused by compressibility of the material were very fully considered. He studied a sufficient variety of models to straddle all reasonable possibilities. He showed that, in general, the results he had already obtained applied without significant modifications. A series of pseudo-spheroids branches off into a series of pseudo-ellipsoids, and from these in turn unstable pear-shaped figures branch away. The numerical constants are somewhat modified, but the general development is essentially the same. Jeans, however, added a new possibility to the former theory: the mass may separate in a new manner which he has called "equatorial break up." Owing to the compressibility of the material the protuberance of the equator takes a sharper form, and for sufficient compressibility and sufficient speed of rotation the figure, instead of being a spheroid, becomes lenticular. If this stage is reached, matter is thrown out in a continuous stream from the equator, where there is now a sharp angle.

> Accordingly we have at one extreme the incompressible liquid, which breaks up by elongating itself under excessive spin, the elongated figure becoming furrowed and so dividing into two parts. At the other extreme we have highly compressible matter such as the perfect gas, which never reaches sufficient elongation, but squirts out matter all around the equator and so avoids the impending catastrophe—like the prudent balloonist throwing out ballast to avoid the bump. In the intermediate cases it is a tussle between these two forces of separation as to which shall get into operation first and forestall the other; and according as the compressibility is above or below a critical value the disruption occurs in the second way or the first (Eddington).

In deriving astronomical consequences of these investigations, Jeans has been a bold speculator surveying the whole universe—the evolution of extragalactic nebulae, the formation of double stars by fission, and the origin of the solar system. Concerning the last, Jeans concluded that "it is probable, though by no means certain, that we must abandon the nebular hypothesis of Laplace." Instead, he pictured the formation of the solar system in the following terms:

> We conjecture that something like 300 million years ago our sun experienced an encounter of this kind, a larger star passing within a distance of about the sun's diameter from its surface. The effect of this, we have seen, would be the ejection of a stream of gas towards the passing star. At this epoch the sun is supposed to have been dark and cold, its density being so low that its radius was perhaps comparable with the present radius of Neptune's orbit. The ejected stream of matter, becoming still colder by radiation, may have condensed into liquid near its ends and perhaps partially also near its middle. Such a jet of matter would be longitudinally unstable, and would condense into detached nuclei which would ultimately form planets. The more liquid planets at the end of the chain would be those of smallest mass; the gaseous centre would form the larger planets Jupiter and Saturn. Owing to the orbital velocity which had been communicated to these planets by the attraction of the passing star, they would not fall back into the sun, but would describe elliptic orbits, passing fairly near to the sun's surface at their closest approach. As they passed relatively near to the sun, the same process as resulted in the formation of planets out of the sun may have resulted in the formation of satellites out of the planets.

If, indeed, the sun could not give birth to planets without calling in the aid of a neighbor, a conclusion follows which can only be described as sensational. For, it is obvious that to distort the sun beyond stable limits and cause ejection of the planet-building material, the approach of the passing star must have been a close one—so close, in fact, that planetary systems similar to ours must be of rare occurrence in Nature.

It is the usual fate of cosmological theories not to survive, but we should be grateful to Jeans for his bold speculations. As Eddington has said on the occasion of the award of the Gold Medal of the Royal Astronomical Society (1922):

> He might have retired among his mathematical models, where the materials behave as he ordains, and muddly old Nature cannot interfere. There is always an attraction to the mathematician in unimpeachable logical deduction, where the premises are explicitly assigned and the conclusion follows of a certainty. The problems of Nature are different; there we are given, say, half the premises and a quarter of the conclusions, not as fixed data but with varying degrees of probability. The binding chains, forged of rigorous logical reasoning, are needed here just as much as in the problems of pure mathematics; it is the anchorage at either end which is perilous. We are glad that Jeans has engaged on the bolder

> adventure. When, for example, he had arrived at the instability of the pear-shaped figure, he proceeded at once to risk applying it to reconstruct our views of stellar evolution, instead of following the secure path, and, shall we say, generalising his result for a pear-shaped body of n-dimensions. But Jeans' contributions to cosmogony are not to be summed up in snappy sentences—that the solar system was formed by tidal disruption, that a spectroscopic binary cannot be formed until a comparatively high density is reached, that star-streaming must be in the transverse direction, and so forth. How these suggestions will stand twenty years hence, we cannot predict. As Jeans has said: "It has not been part of our task to arrive at a conclusion; the time for arriving at conclusions in cosmogony has not yet come." There are many who think that conclusions of this kind are a measure of the success of an investigator; but they make a great mistake. He is spinning the threads of a great synthesis; and it would be scarcely human, nor indeed scientific, not to cast curious glances at the pattern which is being formed, of which we can gain elusive glimpses. I will not predict how far the final fabric will be like that which we now seem to see through the eyes of our Medalist; but I will predict that in that fabric there are stout threads of his spinning which will not have to be unpicked.

His later volume, *Astronomy and cosmogony* (1928), was less successful. This can be largely attributed to the fact that he chose to take a stand in the growing problems of stellar constitution which was opposed to the natural line of development we owe to Eddington. This was unfortunate, but his critical attitude was not without value. On the positive side we should credit him as a pioneer in the difficult investigations of the stability of gaseous stars and for first drawing attention to the phenomenon of radiative viscosity.

No account of Jeans's life would be complete without mention of his popular books. Their phenomenal sales were equaled only by a few imaginative or religious works. His literary success might have been predicted from his treatises, the nonmathematical sections of which can be enjoyed even by the layman. As expositions of science, these popular books are unexcelled. But they also include his philosophical deductions from modern science, which were contentions. He emphasized the part played by mathematics in science and elevated the second law of thermodynamics into a position of supreme importance. And from the fact that the most important physical laws are statistical in character, he deduced the general indeterminism of Nature. He tended to a form of idealism approaching that of Bishop Berkeley, whom he admired. These opinions could be, and were, easily criticized. But as a contemporary has written, "It should not be forgotten how infinitely preferable they were to the barren scepticism into which so many men of science had sunk, and how great a part Jeans played in rescuing science from that morass."

S. Chandrasekhar

Yerkes Observatory, University of Chicago

Boston Meeting Statistics

John M. Hutzel

Assistant Administrative Secretary, AAAS

The 113th meeting of the AAAS was held in Boston December 26–31, 1946. Ninety-nine years ago, September 24, 1847, the Association of American Geologists and Naturalists meeting in Boston passed a resolution transforming itself into the American Association for the Promotion of Science. A committee was formed to draft the Constitution and Rules of Order, and at the first meeting of the new society, held in Philadelphia the following year, the name was modified to the American Association for the Advancement of Science. In 1849 the Association held its second meeting in Cambridge, and since that date has met in Boston six times: in 1880, 1898, 1909, 1922, 1933, and 1946.

During the early period of its existence the growth of AAAS was reflected in the size of the meetings. In the last two decades, however, the size of the meetings has leveled off while the membership curve has steepened. At the Boston Meeting in 1933, 2,351 persons registered and 1,500 papers were read. In 1946, 2,736 registered and 1,332 papers were presented. The number of members in 1933 was 18,553, whereas in 1946 membership had increased to 31,000.

As the affiliated societies have grown in membership, several that originally met with AAAS have chosen to meet independently to avoid difficulties imposed by hotel limitations. Unfortunately, the advantage of meeting separately is offset to some degree by the disadvantage of isolation. One of the major aims of the Association is to facilitate cooperation among scientists. AAAS maintains an active interest in the major fields of science through its sections, and its annual meeting is now the only place where integrating programs can be developed.

The registration for the meeting at Boston by states and foreign countries was as follows: Africa, 1; Alabama, 7; Alaska, 1; Arizona, 1; Argentina, 1; Arkansas, 1; Belgium, 2; Bermuda, 3; Brazil, 4; California, 41; Canada, 66; China, 2; Colorado, 9; Connecticut, 110; Delaware, 7; Washington, D. C., 107; Ecuador, 1; England, 6; Florida, 14; France, 2; Georgia, 16; Greece, 1; Holland, 1; Hawaii, 2; Idaho, 0; Illinois, 102; India, 3; Indiana, 47; Iowa, 31; Italy, 1; Java, 2; Kansas, 9; Kentucky, 7; Louisiana, 16; Maine, 51; Maryland, 109; Massachusetts, 728; Michigan, 68; Minnesota, 44; Mississippi, 6; Missouri, 20; Montana, 4; Nebraska, 6; New Hampshire, 39; New Jersey, 108; New Mexico, 2; New York, 448; North Carolina, 22; North Dakota, 1; Ohio, 94; Oklahoma, 15; Oregon, 1; Palestine, 1; Pennsylvania, 131; Puerto Rico, 3; Rhode Island, 38; Siam, 1; South Carolina, 7; South Dakota, 3; Tennessee, 12; Texas, 28; Utah, 5; Venezuela, 5; Vermont, 21; Virginia, 34; Washington, 3; West Virginia, 7; Wisconsin, 40; and Wyoming, 11.

NEWS *and Notes*

***Science* was informed on February 25 that the hearings on House Bills for a National Science Foundation, H. R. 942, 1815, 1830, 1834, will be held on March 6 and 7. A total of 8 hours is planned for the hearing before the House Committee on Interstate and Foreign Commerce. This is the Committee which failed to report on the science bills in the 79th Congress. The event is being managed by John H. Teeter.**

The permanent officers of the Inter-Society Committee for a National Science Foundation were elected unanimously at the organizational meeting in Washington on February 23. The new chairman is Edmund E. Day, president of Cornell University, and Harlow Shapley, of Harvard, president of the AAAS, will serve as vice-chairman. Dael Wolfle, executive secretary of the American Psychological Association, became secretary-treasurer of the Inter-Society group. Members of the Executive Committee in addition to the three principal officers are: Isaiah Bowman, president, Johns Hopkins University; Ralph W. Girard, University of Chicago; R. G. Gustavson, University of Nebraska; Henry Allan Moe, secretary general, John Simon Guggenheim Memorial Foundation; W. Albert Noyes, Jr., University of Rochester; and Douglas M. Whitaker, Stanford University. The Executive Committee was empowered to fill vacancies in event any of the members find it impossible to serve.

The meeting, which began at 10 A.M., lasted throughout the day and under the leadership of Kirtley F. Mather, who was the chairman, delegates discussed frankly and in great detail the two principal proposals for a National Science Foundation that are before Congress at the present time (see *Science*, February 14 and February 21). In addition to some 120 delegates from the various constituent groups who were present there were representatives of the Joint Army-Navy Research and Development Board, the President's Scientific Board, the President's Commission on Higher Education, U. S. Public Health Service, and the Office of Naval Research. In general, all of these government agencies approve of a National Science Foundation, and a statement representing the War Department's position having the approval of Gen. Aurand was particularly clear. The statement was read by David M. Delo, chief of the Scientific Manpower Branch of the Research and Development Division, War Department General Staff. The statement follows:

(1) The War Department is specifically interested in the maintenance of the strongest possible scientific research program on a national scale. It realizes that only in this way can the highly trained personnel, the technical devices of warfare, and the necessary reservoir of fundamental scientific knowledge be maintained at a level adequate for national safety.

(2) Since the purpose of the National Science Foundation is to strengthen the national scientific program by centering attention on its fundamental aspects, its scope, and on the training of potential scientists, the war Department is specifically in favor of its establishment.

(3) The administrative structure of a National Science Foundation is not a matter of concern to the War Department so long as it is effective and can accomplish its mission. The War Department, therefore, does not favor one type of proposed legislation as against another from this point of view.

(4) It must be pointed out, however, that the War Department must maintain during time of peace, a close contractual relationship with certain portions of industry which will allow them to mobilize and to expand quickly in time of national emergency so that our production of devices and instrumentalities of warfare can keep pace with the demands for national defense. It is necessary, therefore, that our contracts contain provisions which are acceptable to industry. Hence, if any proposed legislation contains provisions which militate against the maintenance of this close relationship, it cannot be favored by the War Department. As a result, it is our belief that it would be better to ignore the provisions which govern patents in this proposed legislation so that contracts can be let in accordance with the contractual negotiations which have been utilized previously. This point of view was expressed during 1946 in reference to the bills then pending before the 79th Congress.

(5) The War Department must also be free to let research and development contracts wherever it deems them desirable. On the other hand, since the National Science Foundation will form a focal point for the national basic research program, the War Department would undoubtedly ask it to monitor a considerable portion of the basic research now being performed under contract in universities. It would also expect to utilize the advice of the Foundation in the placing of contracts and in determining proper coverage of the necessary fields of investigation.

(6) It must also be noted that the demands for research devoted specifically to the purposes of national defense may vary from year to year. It is our opinion, therefore, that it would be a mistake to specifically limit the amount of defense research.

(7) In summary—(a) War Department research must be performed or contracted for from the primary view of national defense and the interests of the using agency. The War Department cannot, and should not, attempt to subsidize fundamental research on a national basis. (b) The War Department must be free to maintain its normal contractual relationships with universities, foundations, or industry as hitherto, but would expect to work very closely and freely in the fields of fundamental research with the proposed National Science Foundation. (c) The Department unequivocally favors the establishment of a Foundation. It would specifically favor a form of legislation which would allow it to perform the functions and continue the relationships outlined above.

Late in the afternoon Senator Elbert D. Thomas of Utah, who is sponsoring the bill S. 525, spoke informally in support of the bill.

A Group of 40 high school students arrived in Washington, D. C., February 28 for the Sixth Science Talent Institute, last step in the Annual Science Talent Search conducted annually by Science Service for the Westinghouse Science Scholarships.

At a dinner bringing the Institute to a close March 4, one boy and one girl will be awarded $2,400 Westinghouse Grand Science Scholarships; eight winners will be awarded $400 Westinghouse Science Scholarships; and $3,000 additional in scholarships will be granted at the discretion of the judges. Vannevar Bush will address the young contestants and guests at the dinner to be held at the Statler Hotel.

The group of young people includes 9 girls and 31 boys, 14 to 19 years of age, from 32 localities in 16 states and the District of Columbia. They were picked by the judges from 16,558 contestants, of whom 3,197 completed their entries by taking a three-hour science aptitude examination and writing a 1,000-word essay on "My Scientific Project."

Scientific promise in young people has no discernible relation to what their parents do, according to a Science Service study of the parentage of the 40 winners in the current Talent Search. Numerically, occupations of fathers are listed as: eight businessmen, six teachers, three engineers, three lawyers, two investment brokers. The following occupations are represented by one father each: clergyman, publisher, compositor, tailor, carpenter, biologist, laborer, electrician, plant quarantine inspector, well driller, and motion-picture writer. Six of the winners have only one parent living, Science Service disclosed. Ten of the 40 are only children, 20 have at least one brother or sister, and only one comes from a family with as many as four children. About 17 per cent have parents who attended college.

About People

Quentin B. Zielinski, formerly with the Virginia Agricultural Experiment Station, has been appointed associate professor of horticulture at Oregon State College, Corvallis.

Alexander Wetmore, secretary of the Smithsonian Institution, has been elected a foreign corresponding member of the Sociedad de Ciencias Naturales La Salle of Venezuela.

Roy C. Thompson, recently of the Metallurgical Laboratory, University of Chicago, and Radiation Laboratory, University of California, has been appointed assistant professor of chemistry at the University of Texas, Austin.

David A. Saxon, formerly with the Radiation Laboratory, Massachusetts Institute of Technology, has been appointed assistant professor of physics, at the University of California, Los Angeles.

Visitors to U. S.

Two Brazilian physicians, Emmanuel Dias and F. Laranja, members of the Oswaldo Cruze Institute, Rio de Janeiro, are visiting the University of Texas Medical Branch, Galveston. Drs. Dias and Laranja will conduct a study of possible cases of Chagas' disease in Texas in cooperation with Ardzronny Packchanian, director of the Microbiology Laboratory at the Medical Branch.

G. Fraenkel, Department of Zoology and Applied Entomology, Imperial College of Science and Technology, London, has been appointed special lecturer at the University of Minnesota for the spring quarter, 1947. Dr. Fraenkel will give a course in insect nutrition as a part of the graduate teaching program of the Division of Entomology and Economic Zoology.

Grants and Awards

Ross G. Harrison, Yale University, will receive the John J. Carty medal and award of the National Academy of Sciences at the annual meeting of the Academy in April.

The award, made by the American Telephone and Telegraph Company in honor of the late John J. Carty, member of the Academy, may be conferred not oftener than once in two years "on anyone who in the judgment of the Academy has made noteworthy contributions to the advancement of fundamental or applied science in any field." In addition to the gold medal, bestowal carries award of the net accumulated income since time of the preceding award.

In transmitting its recommendation to the Academy, the Committee of Award lauded Dr. Harrison's experimental results leading to the procedure known as tissue culture, obtained as a young man at Johns Hopkins University. The Committee also praised Dr. Harrison's work as chairman of the National Research Council since retirement from active university work in 1938, declaring that he combines sound judgment, sympathy for his fellow man, and a wide comprehension of scientific problems.

"Thus, Dr. Harrison has added to an illustrious scientific career an administrative service that in beneficience and sound results arouses the admiration of his colleagues and merits one of the highest honors which the Academy can bestow," the Committee concluded.

Fellowships

Yale University School of Medicine has announced availability of the following fellowships in the biological sciences: fellowships for research in the medical sciences, including clinical medicine and public health, from the James Hudson Brown Memorial Fund; and the Alexander Brown Coxe Memorial Fellowships in the biological sciences, including medicine. Preference is given holders of the M.D. or Ph.D. degree, and the amount of awards is determined for individual applicants.

Application forms and additional information may be obtained from the Dean, School of Medicine, Yale University, 333 Cedar Street, New Haven 11, Connecticut. Applications should be filed prior to March 15.

The University of Utah, Salt Lake City, has made available 20 research fellowships and the Alumni Development Fund four fellowships for graduate students during the school year 1947–48. These fellowships are open in any department of the University and will range from $500 to $1,000, depending on qualifications of the students. Applications should be submitted to the dean of the Graduate School before March 1.

Other departmental fellowships and assistantships are available to graduate students in many sciences. Applications may be addressed to heads of the departments.

The Utah Humanities Research Foundation also offers two fellowships of $500 and five of $250 for research in regional culture. Applications may be sent at any time to Hector Lee, director of the Foundation.

E. I. du Pont de Nemours and Company will award 69 postgraduate and six postdoctoral fellowships to 46 universities for the 1947–48 academic year, continuing its fellowship plan, adopted in 1918 and designed to provide means for advanced training of chemists, physicists, and engineers.

Each postgraduate fellowship provides $1,200 for a single person or $1,800 for a married person, and a grant of $1,000 to the university. Each postdoctoral fellowship carries an award of $3,000 and a grant of $1,500 to the university. The postdoctoral fellowships, all in chemistry, go to Cornell University, Harvard University, Massachusetts Institute of Technology, University of Illinois, University of Minnesota, and University of Wisconsin.

Of the postgraduate fellowships 42 are in chemistry, 5 in physics, 15 in chemical engineering, and 7 in mechanical engineering.

The California Institute of Technology has created the Harry Bateman Research Fellowship in pure mathematics in honor of the late Harry Bateman, professor of mathematics, physics, and aeronautics at the Institute.

Candidates for the fellowship should have obtained a doctorate or expect to receive it prior to the beginning of the academic year 1947–48. Appointment will be made on the basis of shown promise of independent research in any field of pure mathematics, and the recipient, in addition to research, will teach one upper-class course in mathematics. The appointment will carry a stipend of $3,000 for the academic year and, while normally for one year, it may be renewed for a second year.

Application blanks may be obtained from the Dean of the Faculty, California Institute of Technology, Pasadena 4, California, and must be returned to that address before March 15, 1947.

Colleges and Universities

The University of Mainz has recently been opened in the French Zone of Germany, according to a letter written by Udo Undeutsch, dozent of psychology at the University to H. L. Ansbacher, University of Vermont, December 29. The letter states in part: "Thanks to strong support of the French authorities this university, the full name of which is Johannes-Gutenberg-Universität, was created within the shortest time from literally nothing. It is housed in former antiaircraft barracks of the most modern construction which offer beautiful and ample quarters. Due to existing conditions many very good men could be obtained for the faculty. We have 4,000 students selected from 10,000 applicants. The Institute of Psychology is headed by Albert Wellek, formerly of the University of Breslau."

The Agricultural Experiment Station, Utah State Agricultural College, Logan, Utah, is site of a new legume seed research station for investigation of problems of production of alfalfa and other forage crop seed, established by the U. S. Department of Agriculture. The following men will work on problems connected with legume seed production: F. E. Todd and G. E. Bohart, on pollinating insects; F. V. Lieberman and S. K. Snow, on destructive insects; J. W. Carlson and M. W. Pedersen, on seed production and improvement problems.

The University of Michigan has approved use of $42,000 from general funds of the Department of Engineering Research for construction of an illumination laboratory on the roof of the East Engineering building. The new structure will replace present facilities in Randall Laboratory and provide natural light for study of illumination needs of schools, factories, and houses.

Industrial Laboratories

Eastman Kodak Company, Rochester, New York, recently added the following members to its research laboratory staff: James H. Richmond, Masonite Corporation, Laurel, Mississippi; Herman H. Broene, research fellow, Purdue University; and Chester R. Berry, Cornell University.

Eli Lilly and Company, Indianapolis, Indiana, has appointed H. W. Rhodehamel as executive director and E. C. Kleiderer as assistant executive director in the administrative organization of its expanded research program. Following are directors of divisions: G. B. Walden, biochemical; H. A. Shonle, organic chemistry; K. K. Chen, pharmacology; W. A. Jamieson, biological; R. M. Rice, medical; W. J. Rice, chemical control; F. B. Peck, associate director, medical division; and H. A. Dettwiler, assistant director, biological division, in charge of production.

Distillation Products, Inc., Rochester, New York, has appointed Wilma Kujawski and Mei Yu Dju to its research staff. Miss Kujawski, formerly librarian at the Manhattan Project, University of Rochester, is now in charge of the research library, and Miss Dju, formerly on the staff of the Henry Lester Institute for Medical Research, Shanghai, is conducting fundamental research on vitamin E in nutrition in the Biochemistry Department.

Meetings

The National Academy of Sciences will hold its annual meeting at the Academy Building, Washington, D. C., April 28, 29, and 30.

The opening session of the business meeting, for members only, will be Monday morning, April 28, at 9:00 o'clock in the lecture room. Concluding session for transaction of business of the Academy, including election of new members, new foreign associates, president, home secretary, and two members of the council, will be at 9:00 o'clock, Wednesday, April 30.

Scientific meetings will be held the full days of April 28 and 29, and a public lecture, for which the speaker and subject are to be announced later, will be delivered Monday evening in the auditorium. Each member of the Academy who has a paper to offer for the scientific program or who wishes to introduce a paper by a nonmember should submit to the home secretary's office, 2101 Constitution Avenue, Washington, D. C., the full title and time of delivery, with two abstracts of the paper, not later than April 7.

The annual dinner, at which President and Mrs. Jewett will meet members and guests, will be Tuesday evening, April 28, at the Hotel Washington.

There are no hotel headquarters for the meeting, and since the U. S. Chamber of Commerce will hold a convention of 2,500–3,000 members during the week of the Academy meetings, members are urged to write directly to hotels for reservations as soon as possible.

The Crystallographic Society will hold its second annual spring meeting at the U. S. Naval Academy, Postgraduate School, Annapolis, Maryland, March 19–21. The registration fee of $22.00 includes rooms for Wednesday, Thursday, and Friday nights and meals beginning Wednesday night. The fee is $13.00 for those not requiring rooms or breakfasts. Reservations may be made by writing Newton W. Buerger, Massachusetts Institute of Technology, Cambridge, Massachusetts.

The 21st National Colloid Symposium, official activity of the Division of Colloid Chemistry, American Chemical Society, will be held at Stanford University, Palo Alto, California, June 18–20. The program will consist of a group of papers on "Colloidal Electrolytes" and another on "General Colloid Chemistry," according to J. W. Williams, chairman, National Colloid Symposium Committee.

The Midwest Power Conference will be held March 31 through April 2 with headquarters at the Palmer House, Chicago, Illinois. Sponsored by the Illinois Institute of Technology in cooperation with nine midwestern colleges and eight societies, it is open to all persons interested in power problems. Conference director is Stanton E. Winston, and conference secretary, Edwin R. Whitehead, both of the Illinois Institute of Technology. Mr. Whitehead is now receiving registrations and reservations for luncheons and dinners and has available complete conference programs at the Institute, 3300 Federal Street, Chicago 16, Illinois.

Le Comité Météorologique Internationale will hold its next conference in Washington, September, 1947, to discuss the projected Convention Météorological Mondiale.

The Pan-American Conference on Cartography will be held in Buenos Aires, in September.

The International Congress on Experimental Cytology will be held in Stockholm, July 10–16.

The World Health Organization Interim Commission will meet in Geneva, Switzerland, March 31.

The International Congress for Microbiology will convene in Copenhagen, Denmark, July 20–26.

The Inter-American Conference on National Resources will meet in Washington in May.

Elections

The American Standards Association elected Frederick R. Lack, vice-president and director of Western Electric Company in charge of the radio division, as president for 1947. George H. Taber, Jr., executive vice-president of the Sinclair Refining Company, was elected vice-president. Mr. Lack, a member of the A.S.A. board of directors for the past two years, and vice-president during 1946, was nominated by the Institute of Radio Engineers.

The Division of High-Polymer Physics of the American Physical Society has elected Hubert M. James and Robert S. Spencer to the executive committee. Officers for 1947 are Lawrence A. Wood, chairman; Dr. James, vice-chairman; W. James Lyons, secretary; and Dr. Spencer, treasurer.

The New York City Branch, Society of American Bacteriologists, has elected the following officers for 1947: William W. Browne, College of the City of New York, president; Thomas C. Grubb, research laboratories, Vick Chemical Company, vice-president; Mary B. Horton, Sheffield Farms Company, Inc., councilor to the S.A.B. The president has appointed Gustav I. Steffen, New York City Department of Health, program chairman, and Gladys L. Hobby, Morris L. Rakieten, and Mortimer P. Starr, members of the local council.

Plans have been completed at the National Bureau of Standards for erection of two betatrons, enabling scientists there to extend research, measurements, and standards development into the 50,000,000- and 100,000,000-volt range.

Two immediate problems calling for extensive investigation are determination of measurement techniques and formulation of precautionary principles in use of the betatron for cancer treatment.

For the past 20 years the Bureau has played a central role in development of standards for X-ray dosage measurement and protection. The field has been covered thus far only up to 1,500,000 volts. For this purpose the Bureau now has one of the best-equipped X-ray laboratories in tye world. Because of its facilities and experience in the field of radioactivity as well as X-rays, outside organizations are looking to the Bureau for extension of X-ray measurement activities into the newly-opened multimillion volt range.

Both medical and industrial application of high-voltage radiation will be investigated. Problems of protection in both areas will be studied, and one of the aims of the Bureau is to discover necessary thicknesses and types of construction of protective barriers that will give maximum protection with lowest over-all costs.

The Bureau also plans to make a systematic study of nuclear transformations brought about by exposing materials to the X-ray beam.

The betatron authorized by the 1946 Congress was designed to operate up to 50,000,000 volts, but the building will house equipment up to 150,000,000 volts as it becomes available. While building designs are complete, construction has not been started due to increased building costs since appropriation estimates were made. The 1947 budget request calls for addition of a 100,000,000-volt betatron.

The Committee on Geophysical Sciences of the Army and Navy Joint Research and Development Board recently held its first meeting in Washington, D. C. The Committee was established to assist the Board in carrying out provisions of its charter affecting research in physics of the upper atmosphere, meteorology of the lower atmosphere, geomagnetism, geology, hydrology, oceanography, seismology, and geodesy. Members of the Committee which will coordinate Army and Navy research and development activities affecting these sciences are: Roland Beers, chairman, formerly of the faculty of M.I.T.; Carl G. Rossby, head, Department of Meteorology, University of Chicago; Chester R. Longwell, professor of geology, Yale University; Samuel B. Morris, general manager and chief engineer, Department of Water and Power, Los Angeles, California; Rear Adm. R. O. Glover, hydrographer of the U. S. Navy; Capt. Howard B. Hutchinson, aerologist, Office of Naval Research, USN; Col. B. G. Holzman, member of the staff, Deputy Chief of Air Staff for research and development; and Col. D. N. Yates, chief, Air Weather Service.

The U. S. Civil Service Examiners, Philadelphia Quartermaster Depot, have extended the time of the examination for chemist indefinitely, rather than closing it February 6, as previously announced (*Science*, January 17). Duties of the positions involve chemical research and development at the Philadelphia Quartermaster Depot and other agencies in the Third Civil Service Region. Salaries range from $4,902 to $7,102. Applications should be submitted to the Executive Secretary, Board of U. S. Civil Service Examiners, 2800 S. 20th Street, Philadelphia 45, Pennsylvania.

Astronomers and amateurs are planning at least 9 expeditions to observe the total solar eclipse, May 20, from points in South America, according to information received from astronomers in Brazil, Argentina, England, and New Zealand by Charles H. Smiley, Brown University.

Six expeditions will have headquarters in Brazil: two from the United States, one from England, one from New Zealand, and two from Brazil. Three parties will observe from Argentina, but none of these will represent foreign groups.

The Brown University-Skyscrapers Expedition is expected to observe from Araza, about 300 miles northwest of Rio de Janeiro, and the National Geographic Society-Army Air Forces Expedition from Lassance and Bocayuva, about 400 miles north of Rio de Janeiro. The Brazilian groups, as well as an expedition headed by C. B. Michie, New Zealand Astronomical Society, and one led by J. A. Carroll, London, England, are expected to observe from these points.

An expedition under Enrique Gavioli, Argentine National Observatory, Cordoba, is expected to be 50 miles north of Cordoba. A group from the La Plata Observatory will locate near Corrientes in northern Argentina near Paraguay or at Tostado, southeast of Corrientes. A group representing the Asociacion Argentina "Amigos de la Astronomia," under B. H. Dawson, will observe the eclipse at Itati, also in northern Argentina near Paraguay. (*Science Service*.)

Field Laboratories of the Oceanographic Laboratories, University of Washington, at Friday Harbor, San Juan Islands, will be reopened this summer to students and investigators. Plans have been completed for construction of a new $250,000 research and laboratory building, and a research vessel to replace the *M. S. Catalyst* is expected to be in operation this summer.

The Warner & Swasey Observatory, Cleveland, Ohio, has received a gift of a three-inch Transit telescope from Bausch & Lomb Optical Company. Formerly housed in the company's observatory, Rochester, New York, the telescope and recording micrometer were used to observe transit of stars in determining sidereal time. In its new location the instrument will be used principally for instruction.

Last summer Bausch & Lomb gave its large, equatorial telescope to the High Altitude Observatory, operated jointly by Harvard and Colorado Universities at Climax, Colorado.

The Ministry of Education of Afghanistan has openings for 31 American men teachers for positions in government schools in Kabul, the capital, and Kandahar, center of Afghan history and Pushtu culture. Teachers, who are required to have B.A., M.A., B.S., or M.S. degrees and actual classroom teaching experience, are needed to teach the following subjects in English: mathematics, physics, chemistry, biology, geography, and geology. The Ministry offers three-year contracts and travel expenses both ways. Further information may be obtained from the Division of International Exchange of Persons, Department of State, Washington, D. C.

Recent Deaths

Fred Winslow Morse, 81, died January 29 at his home in Amherst, Massachusetts. He was emeritus professor at Massachusetts State College, Amherst, where he had been active in the Agricultural Experiment Station from 1910 to 1935.

Moses Gomberg, 81, former chairman of the Chemistry Department, University of Michigan, died February 12 in Ann Arbor, Michigan. Dr. Gomberg was credited with discovering trivalent carbon and was noted for his work in the triphenylmethane series. He also was credited with developing the first satisfactory antifreeze compound for automobile radiators and finding important new solvents for automobile lacquers. He was past president of the American Chemical Society and one-time vice-president of the AAAS.

NRC News

The Sixth Report of the Committee on Marine Ecology as related to Paleontology (1945–46), recently issued, is a bound, mimeographed bulletin of 101 pages, containing material presented at the annual meeting of the Division of Geology and Geography.

The report contains an outline for a comprehensive Treatise on Marine Ecology and Paleoecology that the Committee will prepare with the aid of interested specialists. Included also are eight signed reports. Four are annotated bibliographies of ecological studies that have been carried on in the Pacific area; the remainder, special ecologic studies. The report gives information on current and recently completed activities together with a current bibliography and summary reviews. Requests for copies should be addressed to the Division of Geology and Geography, National Research Council, 2101 Constitution Avenue, Washington 25, D. C., accompanied by a remittance of $.50 for each copy desired.

A report of the Joint Committee on Forestry of the NRC and the Society of American Foresters, "Problems and Progress of Forestry in the United States," was published by the Society February 1. The report summarizes the history of American forestry, describes the extent, character, and condition of American forests, and explores the problem of drain by utilization and losses through fire and other injurious agencies. The facts concerning public ownership of forests, the problems of private forestry, the place of government activity in advancing forestry on private lands, and education and research in forestry are dealt with in separate sections.

This report culminates two years or more of study by the Committee and especially its chairman, Henry S. Graves, dean emeritus, Yale School of Forestry, and formerly chief of the U. S. Forest Service. It fills the need for a picture of the present forest situation in the United States and for determination and interpretation of problems that are not being met through existing agencies.

Make Plans for—

American Society of Mechanical Engineers, spring meeting, March 2–5, Tulsa, Oklahoma.

Institute of Radio Engineers,

national convention, March 3–6, Hotel Commodore, New York, New York.

University of Pittsburgh Department of Psychology conference, "Current Trends in Psychology," March 5–6, Pittsburgh, Pennsylvania.

Western Metal Congress and Exposition, fifth, March 22–27, Civic Auditoriums, Oakland, California.

American Association of Anatomists, annual meeting, April 3–5, Mount Royal Hotel, Montreal, Canada.

American Geophysical Union, 28th annual meeting, April 28–30, National Museum, Washington, D. C.

Southwestern Division, AAAS, 23rd annual meeting, with Colorado-Wyoming Academy of Science, May 1–3, Colorado College, Colorado Springs.

Society of American Bacteriologists, annual meeting, May 12–16, Bellevue-Stratford Hotel, Philadelphia, Pennsylvania.

American Association of Cereal Chemists, 32nd annual meeting, May 19–23, Hotel President, Kansas City, Missouri.

American Oil Chemists' Society, 38th annual meeting, May 20–22, New Orleans, Louisiana.

American Society of Mechanical Engineers, oil and gas power 19th national conference, May 21–24, Cleveland, Ohio.

American Society of Mechanical Engineers, aviation meeting, May 26–29, Los Angeles, California.

American Society of Mechanical Engineers, wood industries national conference, June 12–13, Madison, Wisconsin.

American Society of Mechanical Engineers, semiannual meeting, June 16–19, Chicago, Illinois.

American Society for Engineering Education, 55th annual meeting, June 18–21, University of Minnesota, Minneapolis.

Chemical Society, London, centenary meeting, July 15–17, London, England.

International Congress of Pure and Applied Chemistry, 11th annual, July 17–24, London, England.

International Physiological Congress, 17th annual, July 21–25, Oxford, England.

COMMENTS *by Readers*

In the *Mathematical Cuneiform Texts*, edited by O. Neugebauer and A. Sachs, page 35 (1945), the authors note that "we now have an Old-Babylonian tablet which answers the question to what power must a certain number *a* be raised to yield a given number? This problem is identical with finding the *logarithm* to the base *a* of a given number." This remark is followed in the noted volume by some problems which are identical with those appearing in some of our modern textbooks on elementary algebra intended for students who are beginning the study of logarithms. For instance, the problems prove that $\frac{1}{4}$ is the logarithm of 2 to the base 16 and that $\frac{3}{4}$ is the logarithm of 8 to the base 16. This involves the use of fractional exponents.

Another extreme view relating to the same subject is quoted approvingly in volume 2 of the widely consulted textbook on the history of elementary mathematics by the late D. E. Smith of Columbia University, page 512 (1925), as follows: "The invention of logarithms came on the world as a bolt from the blue. No previous work had led up to it, foreshadowed it or heralded its arrival. It stands isolated, breaking in upon human thought abruptly without borrowing from the work of other intellects or following known lines of mathematical thought." It should be emphasized that this statement was made in 1914 in Edinburgh at the Tercentenary of the publication of a volume on logarithms by John Napier (1550–1617).

It might have been thought that 300 years would be sufficient time to establish the merits of an individual as regards his contribution towards the development of such an important subject of elementary mathematics, but from the above it is clear that widely different views relating thereto may be held by those supposed to be in good positions to judge even after this long period of time. A striking feature of the difference of these views is that they exhibit some of the difficulties involved in the study of the history of science, which has been too much neglected during recent years.

It should, however, be emphasized that the view noted in the second paragraph of this letter is in complete disaccord with that usually held by mathematical historians notwithstanding its appearance in a widely consulted book in our schools. Few subjects involve so many clear steps toward their modern status in the school curriculum as that of logarithms. Hence, the given quotation from the report of an international meeting may also serve as an instance of a historical statement which would naturally arouse much disagreement after the facts relating thereto have been carefully considered by the students of a class in the history of mathematics. Such disagreement may tend to fix these facts more clearly in the minds of the student, provided they are freely expressed. (G. A. Miller, University of Illinois.)

It is believed that the darkening of fruits and vegetables, upon being cut and exposed to the air, is in part similar to that age-old process in the soil whereby the ferruginous silicates, sulfides, and anhydrous oxides are oxidized to the ferric compounds to form brown and red soils, according to Jackson B. Hester, Riverton, New Jersey. The iron in the fruits and vegetables is originally in the form of ferrous compounds which do not impart a brown color, but upon exposure to air are oxidized to ferric compounds which are brown. The change of ferrous iron to ferric iron has been verified by the author by extracting apples, horse radish, potatoes, etc., with strong acetic acid and making the test for ferrous and ferric iron. At the outset the iron occurs largely in the ferrous state, but after exposure to the air or upon long storage it appears in the ferric state, thus imparting a brown discoloration.

TECHNICAL PAPERS

Comparative Toxicity of DDT Isomers and Related Compounds to Mosquito Larvae and Fish[1]

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Laboratory and field investigations conducted during the last three years have shown that DDT is highly toxic to both mosquito larvae and fish (*1*). Because of its toxic effects on fish, the usefulness of DDT in mosquito control is at present restricted to areas where no danger of poisoning fish exists. The studies here described were made with the purpose of ascertaining to what extent certain isomers and analogues of DDT vary in their toxic properties to fish and mosquito larvae. Accordingly, toxicological tests were carried out on mosquito larvae, *Aëdes aegypti*, and on goldfish, *Carassius auratus*, with two isomers and two analogues of DDT, and with DDT-technical grade as follows:

(1) DDT—Technical grade [Dichlorodiphenyl trichloroethane]
(2) p,p'-DDT isomer [1-trichloro-2,2-bis(p-chlorophenyl)ethane]
(3) o,p'-DDT isomer [1-trichloro-2-o-chlorophenyl-2-p-chlorophenylethane]
(4) DDD analogue [1-dichloro-2,2-bis(p-chlorophenyl)-ethane]
(5) Methoxy (CH_3-O) analogue [Di(p-methoxyphenyl)-trichloroethane]

The tests on mosquito larvae were made in beakers, each containing 200 cc. of distilled water and about 50–60 fourth-instar larvae of *A. aegypti*. One cc. or less (depending on the dilution in parts per million desired) of ethanol containing various concentrations of the toxicants was dispersed in each beaker. Preliminary check tests showed that such small amounts of ethanol alone had no effect on the larvae. Each concentration was run in four replications, giving a minimum of 200 larvae per test. At the end of 48 hours the dead and live larvae were counted. During this period some of the larvae had pupated, and the live pupae were included with the surviving larvae.

The results, summarized in Table 1, show that the o,p'-DDT isomer is decidedly less toxic to larvae than any one of the other four compounds tested, requiring about 2.5 ppm to produce 100 per cent mortality, as compared with 0.1–0.2 ppm for the other compounds. In concentrations of 0.05 ppm or lower the methoxy analogue proved less toxic to larvae than either the DDD analogue or DDT. No significant difference in toxicity between technical DDT and the pure p,p'-DDT isomer was observed in the concentration here tested.

The tests on goldfish were made in glass jars, each containing 3 l. of water and 5 fish, 6–9 months old. About 1 cc. or less, as required, of ethanol solutions containing various concentrations of the toxicants was stirred into jars. The highest amount of alcohol added to any one of the jars was 1.2 cc., or .04 per cent. In this manner, dilutions ranging from .06 to 4 ppm of toxicant in water were obtained. The tests were repeated four times, giving a total of 20 fish per dilution. Observations were continued for four days without feeding. During this period the dead fish were removed as soon as they were noticed.

TABLE 1

COMPARATIVE TOXICITY OF DDT (TECHNICAL), TWO DDT-ISOMERS, AND TWO DDT ANALOGUES TO LARVAE OF *A. aegypti*

Dilution (ppm)	DDT (Technical)	Larvae dead in 48 hours (%)			
		p, p'-DDT isomer	o, p'-DDT isomer	DDD analogue	Methoxy analogue
5.0	—	—	100	—	—
2.5	—	—	94	—	—
1.0	100	100	90	100	100
0.5	100	100	75	100	100
0.2	100	100	22	100	100
0.1	100	100	6	100	88
0.05	100	100	4	100	40
0.025	90	92	3	81	9
0.012	75	75	—	73	3
0.010	35	40	—	65	—

Check—0.5 per cent alcohol = 3 per cent larvae dead

TABLE 2

COMPARATIVE TOXICITY OF DDT (TECHNICAL), TWO DDT ISOMERS, AND TWO DDT ANALOGUES TO *C. auratus*

Dilution (ppm)	DDT (Technical)	Dead after 4 days (%)			
		p, p'-DDT isomer	o, p'-DDT isomer	DDD analogue	Methoxy analogue
4.0	—	—	100	100	—
2.0	—	—	80	100	—
1.0	100	100	50	60	100
0.5	100	100	15	25	100
0.25	100	100	10	10	100
0.125	40	90	—	—	90
0.0625	10	60	—	—	60

Check—.04 per cent alcohol = 10 per cent fish dead

The results, summarized in Table 2, show that the o,p'-DDT isomer and the DDD analogue are definitely less toxic than any one of the other three compounds, both requiring about 2–4 ppm to give 100 per cent mortality, as compared with only 0.25 ppm for the other compounds. In lower concentrations, such as 0.06 ppm, the p,p′-DDT isomer and the methoxy analogue showed higher toxicity than did the technical DDT.

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[1] Journal Series paper of the New Jersey Agricultural Experiment Station, Rutgers University, Department of Entomology.

Summary. The p,p′-DDT isomer is several times as toxic as the o,p′-DDT isomer to both goldfish and mosquito larvae. The methoxy analogue equals DDT in toxicity to fish, but is less toxic to mosquito larvae. On the other hand, the DDD analogue ranks about as high as DDT in toxicity to mosquito larvae, but appears to be less toxic to goldfish.

Reference

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The Functions of the Intercortical Neurones in Sensorimotor Coordination and Thinking in Man[1]

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The manner in which the association pathways of the brain of man integrate the effects of stimulation to cause verbal and motor response represents a central problem of physiological psychology. Some aspects of this problem have been investigated experimentally by the study of individuals in whom the intercortical pathways were sectioned with the objective of controlling convulsions (*1*).

Methods

Response times of three major types of reactions were measured before and after section of the principal nerve bands which connect the two cerebral cortices: (1) simple reaction to visual, auditory, and tactile stimuli; (2) visual discrimination reactions; (3) verbal reactions in free-word association, opposites association, and part-whole association. The discriminatory reactions studied consisted of reactions involving presumably uncrossed relations between the two cerebral hemispheres (stimulation of one hemiretina, excitation of one hemisphere, motor response originating in the excited hemisphere), and crossed relations between the two cerebral hemispheres (stimulation of one hemiretina, excitation of one hemisphere, motor response originating in the unexcited hemisphere). The anatomical relations which may be assumed to be concerned in these crossed and uncrossed reactions, four each of which were measured, are shown in Figs. 1A and 1B.

Suitable reaction time equipment consisting of timing devices, manually operated keys, voice keys, and essential electrical circuits were devised to make the measurements.

Six subjects were used in the principal part of the experiment. The responses of these individuals were measured preoperatively and postoperatively under the best obtainable conditions of their health and cooperation. The operative procedures concerned, as described in the neurosurgeon's notes taken at the time of operation, were as follows: (Subject 1) complete section of the corpus callosum; (Subject 3) complete section of the corpus callosum, and about one year later, section of the anterior commissure; (Subject 13) section of the corpus callosum except for 1 cm. at the tip of the splenium; (Subject 16) section of the corpus callosum except for a few fibers at the tip of the splenium and section of the left limb of the fornix; (Subject 19) section of the anterior two-thirds of the corpus callosum and bilateral section of the limbs of the fornix. Fig. 2 indicates the maximal and minimal extent of the section of the corpus callosum in these subjects.

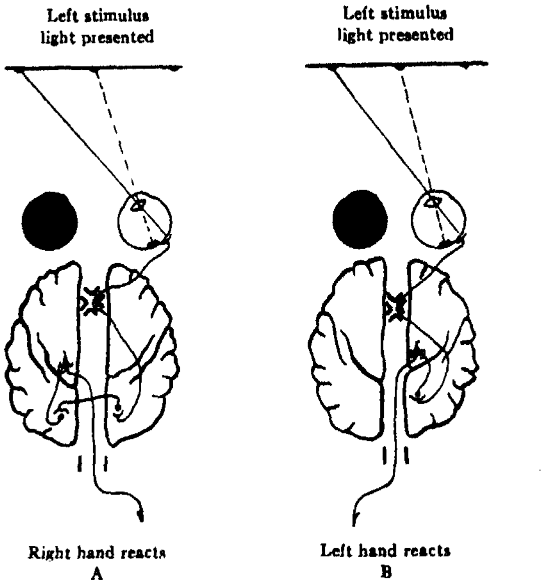

Fig. 1. The hypothetical difference between crossed (A) and uncrossed (B) visual discrimination reactions. (Instructions—A: respond to left light with right hand and to right light with left hand; B: respond to left light with left hand and to right light with right hand.)

Theory

The extensive nerve connections between the two cortices make up, anatomically, a major part of the total associative mechanism of the brain. If this mechanism consists of a network of discrete neural paths for conducting impulses related to verbal activity and thinking, it seems reasonable that cutting the intercortical fibers would disturb numerous verbal associations. Furthermore, one would suppose that cutting these connecting fibers would disrupt specifically the crossed sensorimotor reactions, as described above, whereas the uncrossed reactions would not necessarily be disturbed.

Results and Discussion

The results of the experiment are given in Table 1. Column 6 in the table presents the means of the differences between the preoperative and postoperative tests, and Column 7 gives the values of the *t*-ratios for these means.

The results show that the cortical association neurones connecting the two sides of the brain have a significant role in determining direct responses to visual, auditory, and tactile stimuli, each of which is more or less similarly affected by the operations concerned. Since quite divergent types of reactions were involved and because the patterns of response were unaltered by the operations, one may deduce that this role is one of dynamic regulation rather than discrete participation in the essential nerve channels of the responses.

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[1] The present experiments were made possible by the cooperation of Dr. William P. Van Wagenen, who performed the neurosurgical operations, and by Dr. Andrew Akelaitis, who aided in some of the observations on the patients.

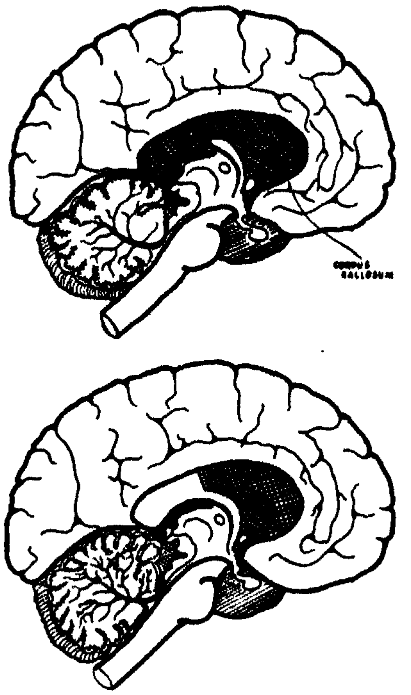

FIG. 2. The extent to which the fibers of the corpus callosum were cu in cases with complete section (top) and in a case with the least extensive lesion (bottom).

TABLE 1

RESPONSE TIME (HUNDREDTHS OF A SECOND) IN DIFFERENT PSYCHOLOGICAL REACTIONS BEFORE AND AFTER SURGICAL SECTION OF THE COMMISSURAL PATHWAYS

Psychological reactions	Preop.		Postop.		M_d	t	Level of confidence	Diff. (%)
	M	σ	M	σ				
Simple reaction time	.18	.042	.29	.078	.11	4.68	.01	+61
Visual discrimination reaction time	.38	.074	.44	.062	.06	1.85	*	+16
Word association	1.62	.372	1.82	.507	.20	1.10	*	+12
Visual discrimination reaction time (uncrossed)	.37	.076	.43	.066	.06	1.88	*	+16
Visual discrimination reaction time (crossed)	.39	.076	.45	.067	.06	2.17	*	+15

* Indicates a value below an acceptable level of confidence.

Crossed sensorimotor reactions and verbal associations are not significantly affected by the surgical section of the commissural neurones. These are the functions which should be radically disrupted by lesions of the intercortical nerve bands if the cortex, in fact, functioned as an array of specific association pathways. Accordingly, the results tend to support the view that the associative mechanism of the cortex acts in terms of generalized patterns of excitation rather than as a system of specific pathways between sensory and motor centers. Such patterns of neural activity evidently include the subcortical centers, at which level integration between the two sides of the brain can be made when the cortical commissural paths are destroyed.

The results found for simple response times appear to explain the persistence of inertia in patients with surgical lesions of the commissural pathways of the cortex. This defect in response time is the only well-established disturbance resulting from destructions of these pathways.

A more detailed statistical treatment of the present results is in preparation.

Reference

1 VAN WAGENEN, W. P., and HERREN, R. Y. *Arch. Neurol. Psychiat.*, 1940, **44**, 740-759.

Penicillin Site of Action

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In a recent article, C. S. Leonard (*3*) has criticized some views postulated by our group on the mechanisms of antibiotic action, particularly with reference to the action of penicillin.

A principal fallacy in Leonard's arguments is that he apparently presumes that all agents which inhibit growth of microorganisms by interaction with sulfhydryl groups should demonstrate more or less equal toxic manifestations in animals and should inhibit the same types of organisms. For this to be true, one needs to assume that there is only one type of sulfhydryl-active enzyme present in all species of organisms. It could also require that only one type of chemical reaction occur between inhibitor and sulfhydryl group.

There is evidence that many sulfhydryl enzymes occur (*1*) and that all sulfhydryl groups are not equivalent. Sulfhydryl groups might be expected to differ in availability and reactivity depending upon whether they are superficial or deep in a protein, and depending upon the nature of neighboring groups capable of adsorbing or activating an inhibitor. We have shown (*2*) that marked differences exist in reactivity of sulfhydryl groups toward some antibiotics, including penicillin, depending upon the nature of other groups (such as the amino) present in the vicinity of the $-SH$.

The theory of antibiotic inhibition of enzyme-SH groups has not been postulated for all antibiotics, but only for a large group which has the common feature of reactivity toward one or more types of $-SH$ compounds. Even in this group there may be members in which the $-SH$ reaction is not the primary inhibition mechanism. Although it would be possible to classify antibiotics on the basis of other reactions, such as reactivity toward acids, alkali, or thiosulfate, our group feels that although the others are interesting, the most significant from a mechanism-of-action standpoint are those which have a direct biochemical significance, such as the $-SH$ reaction. This investigator knows of no biological system in which thiosulfate plays a role.

Some of Leonard's conclusions are puzzling. In our work, not only pyocyanine but all the other antibiotics tested were observed for reactivity with thiols *in vitro*. *In vivo* tests (antibacterial action) were used only as an analytical tool in measuring disappearance of antibiotic activity. We were primarily interested in inactivation as a measure of chemical reactivity.

The relevance of thioglycolate stimulation of penicillinase action or of the rapid excretion of penicillin to the mechanism of action of penicillin is nebulous at present and is certainly not evidence for or against a sulfhydryl inhibition mechanism. We do not agree that thiol inactivation of penicillin cannot proceed in broth or other such media provided sufficient inactivator is used; such media may, however, require more inactivator.

We agree with Leonard that it has not been proven that penicillin binds protein —SH groups, and it is this lack of proof which leads us to call —SH inhibition by penicillin only a theory. This author disagrees, however, with the statement that penicillin needs to bind protein —SH in direct proportion to the number of —SH groups in proteins, since we have shown that some types of —SH groups react only sluggishly or not at all with penicillin. It may be this very selectivity of the —SH reactions which endows penicillin with specificity of inhibitory action.

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2. Cavallito, Chester J. *J. biol. Chem.*, 1946, **164**, 29.
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Leptospiral Infection Among Rodents in Micronesia

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Murine leptospirosis is a problem of public health importance because the causative organism, *Leptospira icterohemorrhagiae*, is capable of infecting humans and producing Weil's disease. Leptospirosis is gradually gaining recognition as a common disease of man giving rise to, among other things, jaundice, muscular tenderness, or comparatively mild symptoms. It is believed by several workers (*3, 4, 5*) that this disease is by no means rare, and the infrequency with which it has been reported is probably due to failure of recognition.

Although many surveys have been conducted on the incidence of leptospirosis in various parts of the world, notably Australia, Europe, India, Japan, and the continental United States, very little is known of the incidence of murine leptospirosis in the Pacific Islands. In recent years it has been shown (*1, 2*) that murine leptospirosis is present in the Hawaiian Islands, especially in areas having high rainfall and an abundance of rodents. Awareness of this fact indicated the need for further study of this disease in other islands of the Pacific. During July and August 1946, a preliminary survey was conducted by the writer under the sponsorship of the University of Hawaii Pacific Islands Research Committee to determine, among other things, the possible occurrence of murine leptospirosis on the island of Moen of Truk Atoll and on the island of Ponape, both of the eastern Carolines. Of 22 rats trapped on Moen and 18 trapped on Ponape, 3 and 2, respectively, showed presence of leptospirae in the urinary tubules (Fig. 1). The diagnosis was based on examination of kidney tissues fixed in formalin and stained by the silver impregnation technique (*2*).

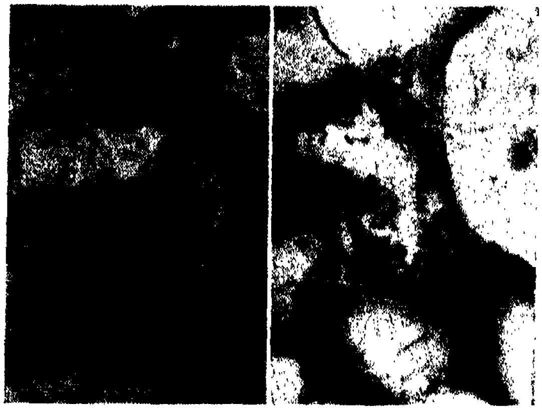

Fig. 1. *Sections of kidney of rat from Truk showing leptospirae in the urinary tubules.*

As far as is known to the writer, this report represents the first record of murine leptospirosis in any of the islands of Micronesia and lends support to the belief that Weil's disease occurs in man in that area. Mumford and Mohr (*6*), in summarizing various diseases of man recorded from the Japanese mandated islands, state that according to the 1930 Report of the League of Nations, two cases of Weil's disease occurred in 1929 among Japanese in those islands. They also mentioned the possibility that the above cases might have been those of "infective hepatitis," and, conversely, cases which had been reported previously by other workers in the Marshalls as "catarrhal icterus" might have been cases of Weil's disease.

Although further research studies in Micronesia are necessary, the present finding points out that human leptospirosis is probably present in the area and more common than heretofore believed. The combination of high rainfall and abundance of rodents in Micronesia presents factors which are very favorable to the spread of the disease.

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IN THE LABORATORY

Chemical Sterilization of Bacteriological Media by Means of Mercuric Oxycyanide and Subsequent Inactivation of the Mercurial by Thioglycolate

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Sterilization of bacteriological media is accomplished by heat or filtration. Media containing blood, ascites, etc. cannot always be treated along these lines, and there remains only aseptic handling of these compounds, which is, however, not always feasible.

We therefore tried to achieve a chemical sterilization of bacteriological media. The principle of the method is, in brief, addition of a chemical disinfectant, the effect of which is afterwards cancelled out. An effect of this type was demonstrated by Brewer (*2*) and Fildes (*3*), who were able to neutralize the bactericidal action of various mercurials by addition of substances containing —SH groups. Similarly, Woods (*5*) showed that *p*-aminobenzoic acid antagonizes the action of sulfanilamide. Only bactericidal agents are suitable for sterilization by chemical means; materials which act mainly bacteriostatically do not fit the purpose. Also, not every antiseptic whose action can be neutralized is suitable; for example, sublimate in bactericidal concentration is a strong coagulant of proteins, thus changing the chemical as well as the physical properties of the medium.

TABLE 1

Thioglycolate Concentration Needed for Reactivation of Mercuric Oxycyanide (MOC) Sterilized Medium

Organism tested	Medium	Bactericidal concentration of MOC (no growth)	Neutralizing concentration of thioglycolate (full growth)	MOC: thioglycolate ratio
Staphylococcus aureus	Broth	1:100,000	1:50,000	1:2
	Broth + 5% blood	1:10,000	1:5,000	1:2
	Broth + 10% blood	1:10,000	1:5,000	1:2
Streptococcus pyogenes	Broth + 10% serum	1:25,000	1:10,000	1:2,5
Escherichia coli	Broth	1:100,000	1:50,000	1:2
Eberthella typhosa	Broth	1:100,000	1:50,000	1:2

The proposed method consists in treating the medium to be sterilized with a bactericidal concentration of mercuric oxycyanide (MOC). MOC, though a stronger bactericide than sublimate, has practically no coagulating action on albuminoid material and does not attack metals (*4*).

The procedure is as follows: The bactericidal concentration of the mercurial is allowed to act on the medium for at least 24 hours at 37° C. or any other temperature desired. This concentration varies for different media and ranges between 1:50,000 and 1:1,000. [illegible] the container for the medium has not previously been sterilized, it should be stoppered with rubber and shaken several times during the procedure to insure complete wetting of the inner surface. Reactivation of a portion of the medium is then performed by adding sterile sodium thioglycolate. The ratio of neutralizing MOC to sodium thioglycolate is 1:4 according to weight, *i.e.* 20 molecules of thioglycolate neutralize 1 molecule of mercuric oxycyanide (see Table 1). After addition of the proper amount of thioglycolate, the reactivated medium is divided into two parts: one is left uninoculated and serves as control, while the other is inoculated with any organism desired. If sterilization and reactivation are both complete, the control tube remains sterile, while full growth is obtained in the inoculated tube.

There are two shortcomings in the method proposed: (1) MOC, like other inorganic mercurials, sterilizes spores rather slowly (*1–3*). Media, even if heavily contaminated by vegetative forms, become sterile at 37° C. within 6–9 hours, whereas the destruction of spores takes several weeks. This method is, therefore, limited to sterilization of materials and media containing only small numbers of spores. (2) When media containing blood are exposed to the action of MOC for more than 12 hours, haemolysis occurs. This can, however, be stopped by neutralization with thioglycolate.

The advantages of the method are: (1) MOC does not deprive the medium of any essential —SH substances which could not be replaced by thioglycolate. In this respect the medium remains unchanged. The small excess of thioglycolic acid present after inactivation of the mercurial does not affect aerobic organisms, but definitely stimulates the propagation of facultative anaerobes. (2) The inactive complex, MOC-thioglycolate, thus obtained remains stable for at least a month. On the other hand, merthiolate, for example, when similarly treated, gives an unstable compound which releases the free antiseptic after 24 hours. (3) Variations as to the concentration, temperature, and time of exposure to the mercurial are easily produced according to need.

Investigations into the mechanism of the action of mercurials and quantitative relationship for various —SH substances and different bacteria are under way and will be published elsewhere.

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A Spray Mixture Useful for Thinning Apples After Bloom[1]

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A spray mixture consisting of polyethylene polysulfide (Goodrite p.e.p.s.) and a complex product formed by the reaction of zinc dimethyl dithiocarbamate ("Zimate") with cyclohexylamine has been under observation for the past two seasons. The use of this spray mixture has resulted in a 50–60 per cent reduction in fruit set on Delicious and Blaxtayman when applied 10–14 days after full bloom. The proper concentration for apples appears to be 2 pounds of polyethylene polysulfide and ¼ pound of the zinc dimethyl dithiocarbamate-cyclohexylamine complex. Preliminary observations in 1945 and 1946 indicate that the spray mixture will also thin peaches when applied near the shuck-fall period. The results to date are very limited but are sufficiently indicative to warrant more extensive field trials to determine the effect of time of application, concentrations, and repeat applications.

Advantages of this spray mixture over other fruit-thinning sprays are its ease of mixing, noncaustic action, and lack of phytotoxicity. When the mixture is used throughout the scab season for scab control, the control is comparable to that obtained from the use of wettable sulfurs. There are indications that it will also aid in the control of cedar apple rust. In addition, the polyethylene polysulfide is an excellent sticker.

Cross-Sections of Undistorted Human Hair

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Since 1880, anthropologists have been making hair cross-sections in an effort to solve the mechanism of curling and waving, and for racial analysis and classification. Early cross-sections were made using the pith-block technique of the botanist or the embedding techniques of the histologist. The development of cellulose embedding led to a simplified rapid sectioning technique, described by Fiala (*1*) in 1930, and the rapid and useful industrial tool reported by Hardy (*2*) in 1935. The Hardy technique was modified for the anthropologist by Steggerda (*4*) in 1940. Extensive work has also been done with the cardboard support described by Kneberg (*3*) in 1935.

However, all of these techniques required both distortion of the hair form and considerable stretching. The author's study required sections from undistorted hair and serial sections with each hair identifiable in each successive section. These dual requirements led to the development of two techniques: the first, suitable for paraffin embedding; the second, a rapid method for producing thicker sections.

The first method borrows and modifies Kneberg's cardboard support and employs paraffin melting at 62° C. to hold the hair securely. After the hairs have been selected from a single lock, washed in solvent, and the dirt removed, they are affixed to the support with globules of cement. It is important to fix them in place without distorting the wave form and also to space them properly. "Indexing" hairs of larger diameter and bent parallel to the human hairs are set at either side, as shown in Fig. 1. After soaking the finished support in xylol, embedding is completed without dehydration. The paraffin block is cut from the hardened paraffin in the usual manner, the curvature of the enclosed hairs marked on the outside, and the sections made. During sectioning the object carrier of the microtome is readjusted every few rotations so that the sections are perpendicular to the hairs. Sections 15–20 μ, thick cut well. The paraffin sections are floated on albumen-coated slides, dried, and deparaffined. The large fibers at the ends of each section aid in location under the microscope and serve to indicate sections that have been inverted or reverted during handling.

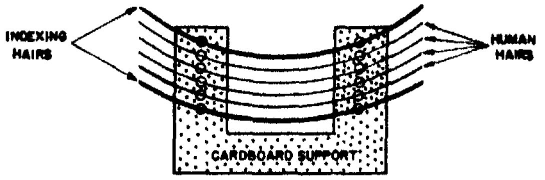

FIG. 1. Embedding support.

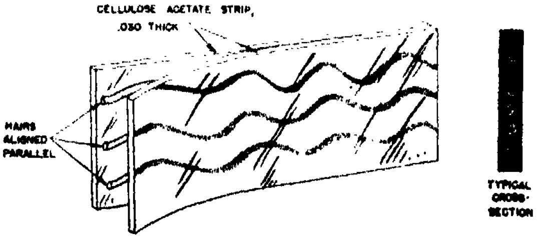

FIG. 2. Lamination technique.

By its constant relative position each hair can be identified in successive sections. The optical activity of the hairs, if any, can be studied in sections so made.

The second method is a rapid but less perfect lamination technique. As shown in Fig. 2, the hairs are oriented on a cellulose acetate strip, tacked down with acetone, and covered with a second acetate sheet. Acetone or a suitable cement may be used for laminating, and moderate heat and a few pounds pressure help the contact. Within 10 or 15 minutes sections can be made either freehand or with the aid of a jig. Again, the sections must be perpendicular to the hairs rather than to the lamination. This technique facilitates rapid study of cross-section form, area, and rotation about the longitudinal axis. Sections should be made within a few days after laminating.

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[1] Published as Miscellaneous Paper No. 20 with the approval of the director of the Delaware Agricultural Experiment Station.

This work was conducted in cooperation with the B. F. Goodrich Company.

Stability of Crystalline Sodium Penicillin G

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A study of solution stability of crystalline preparations of penicillin G indicated that pH and potency dropped rapidly when such solutions (5,000 units/ml.) were stored at either 15° or 24°C.; this behavior is in sharp contrast to the greater stability of earlier, cruder preparations. As this was probably due to the removal during the crystalline process of certain impurities having buffering capacity, a study was initiated to find some substance which would protect the solutions of crystalline penicillin without detriment to the stability of the dry powder when stored in open containers at 100°C.

TABLE 1

Buffer	Initial pH	5,000 units/ml. solution at 24°C.—potency losses*						Solid at 100°C.
		4 days		5 days		7 days		6 days
		% loss	pH	% loss	pH	% loss	pH	% loss
Sodium phosphate	7.2			12.7	6.95			98.6†
" bicarbonate	7.0			33.5	5.1			41.0†
" oleate	7.0			12.4	6.5			100.0†
" acetate	6.7			13.2	5.7			42.0†
" borate	6.7			65.5	4.6			100.0†
" succinate	6.6			21.2	5.8			97.2†
" tartrate	6.6			50.8	4.8			100.0†
" citrate	7.0			8.5	6.5			100.0†
" sulfanilate	5.2	78.4	4.9					7.8
" phthalate	6.1	35.1	4.9			73.7	4.8	1.4
" mandelate	6.1	71.0	4.5					6.3
" benzoate	5.7	60.4	4.6					8.1
" nicotinate	6.0	27.2	5.0			62.1	4.8	10.4
" salicylate	5.9	83.4	4.5					19.6
" sulfamate	6.0	85.7	4.6					18.0
" tartrate	6.1	71.1	4.6					23.9
" gluconate	6.0	81.4	4.5					20.0
" succinate	6.4	7.4	5.3			26.2	5.2	16.8

* Based on values obtained by the spectrophotometric method outlined by R. M. Herriott (*J. biol. Chem.*, 1946, 164, 725–736).

† Samples were dried in such a manner as to yield amorphous mixtures; the others are all crystalline.

Table 1 indicates the results obtained using various buffers to the extent of 5 per cent by weight of the crystalline sodium penicillin co-dried to yield in some cases a crystalline mixture and in others an amorphous mixture, depending upon the procedure employed in the drying process.

For a more detailed study we chose sodium bicarbonate, sodium acetate, sodium succinate, and sodium citrate. The effect of temperature of storage, buffer concentrations, and starting batch material are clearly indicated in Table 2.

It appears that about 5 per cent by weight of penicillin of the buffers studied will protect solutions of crystalline penicillin for at least 4 days at 24°C. and for at least 7 days at 15°C. Those solutions which contain 1 per cent or less buffer exhibit lack of stability comparable to unbuffered solutions, losing over 50 per cent at 24°C. in 4 days.

When applied to plant batches, the average loss in potency[1] of solutions stored at 15°C. for 7 days for 10 unbuffered batches is 26 per cent, while the average loss of potency in these batches buffered with sodium citrate under the same conditions of storage is only 1 per cent.

TABLE 2

Buffer	Batch No.	Conc. buffer (%)	5,000 units/ml. solution—potency losses					Solid at 100°C.
			Initial pH	4 days—24°C.		7 days—15°C.		6 days
				% loss	pH	% loss	pH	% loss
Sodium bicarbonate	1	4.5	7.4	9.3	6.7	3.2	7.2	0.6
		2.25	7.1	10.8	5.8	9.7	6.1	0.1
		0.90	6.8	31.4	4.9	6.8	5.7	0.3
		0.43	6.4	58.9	4.5	15.2	4.8	2.1
Sodium acetate	1	10.0	6.4	3.4	5.7	0.3	5.9	5.0
		5.0	6.5	4.0	5.7	5.3	5.7	8.8
		1.0	6.3	43.4	4.7	7.4	5.3	6.8
		0.1	6.1	76.0	4.4	38.5	4.8	6.0
" succinate	1	10.0	6.3	4.2	5.9	1.7	5.6	3.5
		5.0	6.2	3.4	5.4	11.3	5.7	6.0
		1.0	6.0	62.0	4.6	19.3	5.3	7.0
		0.1	5.8	83.0	4.6	40.5	4.9	7.1
" citrate	1	10.0	6.6	+4.3	5.7	+1.6	6.4	0.3
		5.0	6.6	+6.3	5.3	2.1	6.1	+0.1
		1.0	6.5	65.1	4.4	2.2	5.2	5.9
		0.1	6.2	81.0	4.4	43.9	4.7	8.0
" citrate	2	5.0	6.5	6.2	5.2	+2.3	5.9	4.4
	3	5.0	6.6	+4.0	5.7	+1.3	6.1	14.6
	4	5.0	6.7	+10.1	5.6	1.3	6.0	1.1
	5	5.0	6.5	13.5	4.7	+0.3	5.8	2.4
	6	5.0	6.6	2.3	5.6	2.7	6.2	15.4

From the results obtained it would appear that the decomposition of sodium penicillin in solution is autocatalytic and that, once decomposition starts, it is difficult to control. The rate of inactivation increases rapidly with increases in temperature.

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[1] Based on values obtained by the iodometric method outlined by Joseph F. Alicino (*Ind. eng. Chem.* (Anal. ed.), 1946, 18, 619).

An Operative Approach to the Treatment of *Schistosomiasis mansoni* Infections

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With the finding of a new method for the simple removal of adult *Sch. mansoni* from experimentally infected animals (*1*), a series of interesting observations were made, among which were the following:

(1) The use of heparin simplified the removal of the adult worms from the blood vessels of the experimentally infected animal.

(2) The number of adult worms recovered from the portal vein proper was far greater in animals heparinized before death than in those that had not been heparinized.

(3) A striking number of adult *Sch. mansoni* could be recovered from the livers of animals heparinized before death,

as compared with animals that had not been heparinized.

(4) It is possible to aspirate the portal vein of an heparinized rabbit and keep the animal alive.

The experience gained from working out the procedure for the removal of adult worms served as a basis for an attempt at applying a similar procedure to animals as a therapeutic measure. Thus, a group of animals infected with *Sch. mansoni* were subjected to portal vein aspiration under operating room technique. Five rabbits and two monkeys were operated on by the author and collaborators.[1] All animals received intravenous amytal anesthesia.

From these preliminary experiments a number of observations have been made and therapeutic possibilities envisioned:

(1) In monkeys with infections that closely simulate *Sch. mansoni* infections in humans, it appears entirely possible to aspirate the portal vein of the heparinized monkey and keep the animal alive.

(2) The lighter the infection in monkeys (and the more closely it approximates the mild human variety), the greater the percentage of recovery of adult worms, as determined by post-mortem examination when the animal was sacrificed following surgery.

(3) If heparin is effective in mobilizing the adult worms and localizing them in the portal vein and liver, it may be possible first to use heparin systemically and then anthelmintics directly into the portal vein to produce a large concentration of the drug where it could have a maximum effect on the offending worms.

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Radiographs With C^{14}

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Since the discovery of C^{14} (*3*) there has been a temptation to use it to study the distribution of any desired organic substance in a chemical or biological system. To do this it was necessary only to incorporate C^{14} into the organic molecule and then prepare radiographs in the manner originally described by Marie Curie in her classical experiments with radium (*1*).

Unfortunately, the radiation from C^{14} is one of the weakest known. The β-particles emitted have an energy of only 90 kv., and the half-absorption thickness in aluminum is only 2.6 mg./cm.^{2}, or 0.01 mm. In this respect these rays are very similar to the β-rays of actinium, which have a half-thickness of 2.3 mg./cm.^{2} of aluminum and which, because of their weakness, have eluded detection until only recently (*2*). Thus, when C^{14} was available only from cyclotronic sources, it seemed hopeless to attempt to radiograph it. Now that strong sources are available from the Oak Ridge uranium pile, the situation has changed.

Below we show some C^{14} radiographs obtained in some of our orienting experiments. In all our tests (except the very latest) 35-mm. Eastman "Super XX" film (panchromatic type B) was used. It was developed for 25 minutes at 20° C. in a tank, with intermittent agitation, using Eastman developer DK-20. The resolving power under these conditions is about 60 lines/mm.

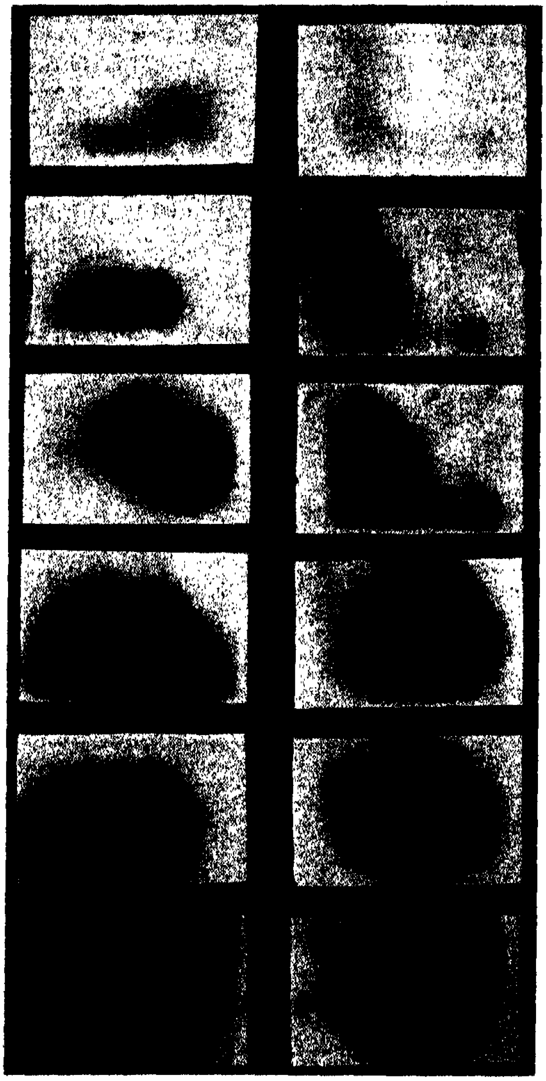

FIG. 1. Direct contact prints made from photographic film exposed to barium-1-radioacetate (left) and 9-radiodibenzanthracene (right).

In the first two series, shown in Fig. 1, about 30 mg. of barium-1-radioacetate and 9-radiodibenzanthracene crystals were placed directly in contact with the emulsion side of the film for varying periods of time. The specific activities of these compounds were, respectively, 266,000 and 3,020 disintegrations/minute and 1 mg. carbon. The time of irradiation, weight of substance, and integrated amount of irradiation are given in Table 1.

By studying Fig. 1 (actually, the original films show much

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[1] Dr. S. B. Beaser, Boston, Massachusetts, and Maj. Richard Upjohn (MC), AUS.

more contrast), we see, *first of all*, that even the comparatively weak dibenzanthracene preparation gives a definite effect after 4 hours. Second, we note that the amount of blackening is approximately proportional to time, until we begin to approach saturation.

TABLE 1

No. of radiograph	Barium-1-radioacetate $[Ba(O \cdot C^{14}O \cdot CH_3)_2]$				9-Radiodibenzanthracene $[C_{22}H_{14}]$			
	Time (hrs.)	Wt. (mg.)	Wt. of C (mg.)	Total No. of disintegrations (× 10^{-7})	Time (hrs.)	Wt. (mg.)	Wt. of C (mg.)	Total No. of disintegrations (× 10^{-7})
1	1.0	27.8	5.23	8.3	4.0	28.8	27.3	2.0
2	4.0	27.8	5.23	33	16	28.8	27.3	7.9
3	17.5	27.8	5.23	146	66	28.8	27.3	33
4	48	33.6	6.32	484	168	26.8	25.4	77
5	168	34.4	6.47	1,730	401	26.8	25.4	184
6	650	30.0	5.64	5,820	427	28.8	27.3	211

Having thus established the effect and the approximate amount of time and activity required, we proceeded to determine the distribution of sodium acetate solution in a small sweet-potato leaf as it was soaked up through its stem. The stem of the leaf was placed for 4 days in a 0.4 per cent aqueous sodium-1-radioacetate solution with a specific activity of 266,000 disintegrations/minute and 1 mg. C. At the end of that period the total C^{14} activity of the leaf corresponded to 7,250 disintegrations/minute. Film exposures made for 11, 21, 42, and 166 hours are shown in Fig. 2 (left to right).

Even the first exposure, corresponding to only 2 microcurie minutes, shows the distribution of C^{14} in the large and small capillaries very distinctly.

As expected, blank experiments on ordinary barium acetate, dibenzanthracene, and a leaf containing ordinary sodium acetate, for similar periods of time, showed no perceptible effect on the photographic film.

Encouraged by these results, we proceeded to take a radiograph of a leaf which had an extremely small activity—only 225 disintegrations/minute. The actual number of counts per minute in this case equaled only half of the background (20). The leaf, obtained through the courtesy of Dr. Guthrie, of the National Institute of Health, Washington, D. C., was grown in an atmosphere containing $C^{14}O_2$. This was exposed to the film for 20 days. The radiograph showed that the distribution of C^{14} is very even throughout the body of the cells, as one would expect, and very little, if any, is found in the capillaries.

In our most recent experiments, Eastman "No-Screen X-Ray Film" was found to be about five times as sensitive to C^{14} radiation as the Eastman "Super XX" used in the above experiments. The exposure times may consequently be reduced to one-fifth of the time using this film. The film affords the possibility of measuring the penetrating power of a radiation, since it is covered by photographic emulsion on both sides. The weak radiation of C^{14} produces an impression on only one side. This can readily be seen by observing the film by reflected light. A second radiograph may therefore be made on the same film, with an element of more penetrating radiation—for instance, P^{32}.

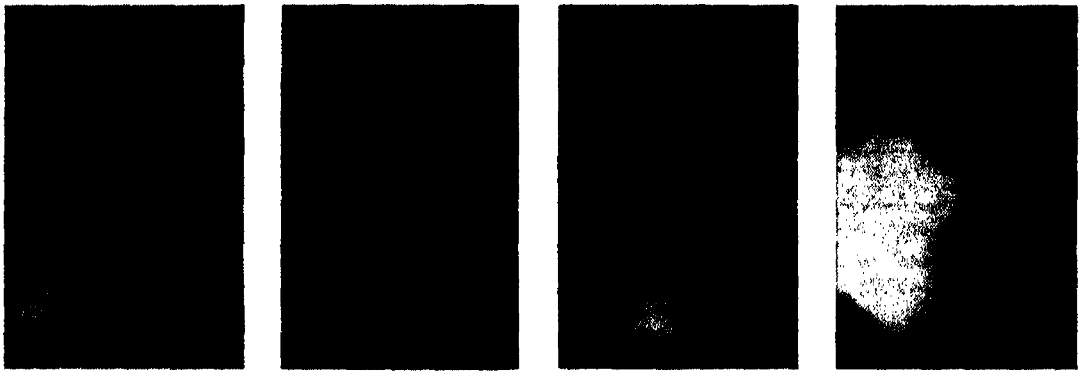

FIG. 2. Direct contact prints made from photographic film exposed to sweet-potato leaf containing C^{14}.

We believe that these results definitely show that present-day films are highly sensitive to C^{14} radiation and indicate the possibilities of the radiographic technique with C^{14} for various biological and chemical studies.

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Book Reviews

Early ambulation and related procedures in surgical management. Daniel J. Leithauser. Springfield, Ill.: Charles C. Thomas, 1946. Pp. xi + 232. (Illustrated.) $4.50.

It has long been recognized that the period of disability following an abdominal operation is largely proportionate to the period of time the patient is immobilized in bed. The author presents experimental and especially clinical evidence based on 2,047 personal cases to show that nearly all patients, after even very serious surgical procedures, may be made to leave their beds daily, beginning a few hours after the operation, with a more rapid, safe, and comfortable convalescence than if prolonged immobilization had been used. This opinion is reinforced by many quotations from the literature which emphasize the growing modern tendency toward shorter periods of bed rest after operation. Definite rest periods are balanced by periods of activity, for which the author describes graduated bed exercises as well as the particular preoperative and postoperative treatment he personally uses.

Sound evidence has been accumulated that serious postoperative respiratory, circulatory, and gastrointestinal complications may be prevented or controlled by activities such as those described by the author. For example, in the author's series of over 2,000 cases there was no instance of pulmonary embolism. Important aids which are detailed are the use of anatomic muscle-splitting incisions, delicacy in handling tissues, and the security and lack of irritation in wound closure by the use of buried sutures of stainless steel wire. While surgeons often will use their own rather than the special technical procedures preferred by the author, and may hesitate to employ early ambulation for patients with circulatory failure and diffuse septic peritonitis, they will be repaid by reading this very complete discussion of early postoperative ambulation and an associated operative technic with pre- and postoperative treatment.

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Functional anatomy of the mammal. W. James Leach. New York-London: McGraw-Hill, 1946. Pp. viii + 231. (Illustrated.) $2.50.

This book was written to "supplement courses in human anatomy (and physiology); to serve as the mammalian portion of courses in comparative vertebrate anatomy; or to be used in courses principally concerned with general mammalian features."

The first few pages are devoted to general anatomical considerations, for the human as well as the cat. Then follows a description of the conventional vertebrate systems: skeletal, muscular, alimentary, respiratory, vascular, urogenital, and nervous. A chapter on superficial dissection of the cat is interposed between the chapters on the skeletal and muscular systems, and a survey of internal anatomy precedes the alimentary system. The text ends with chapters on the special sensory apparatus and the endocrine organs. The functional aspects of the organs and systems are referred to throughout. An appendix gives some brief suggestions for preserving laboratory material.

The text is sufficiently illustrated with noncolored diagrams and figures. The names of structures and processes are featured in bold type as they are introduced. A check list of muscles, with pronunciation and derivation indicated, follows each muscle group. A useful tabular summary of the main blood vessels and the cranial nerves is included. At intervals provocative problems of a correlative nature are suggested for solution.

Typographical errors are at a minimum, very few inconsistencies occur between labels of diagrams and names used in the text, and vague statements that tend to confuse rather than clarify are not numerous.

All in all, this book should be very useful as a supplemental text.

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The Chemical Production of Mutations

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A GENETIC MUTATION IS A CHANGE, presumably chemical in nature, in one of the genes which compose the chromosome thread. The mutated gene is as stable as the original; it goes on reproducing replicas of its mutated self and thus initiates a new hereditary line. It is believed that without mutation life would never have proceeded beyond its very first elementary beginnings. Yet the mechanism of this important process is practically unknown. With the discovery by H. J. Muller (*12*) that mutations can be produced artifically by X-rays, a new approach to the problem of mutation was opened up, and many new facts relating to this problem were brought to light. One of the most important results was the discovery that the term "mutation" includes a number of distinct processes. In addition to gene mutations as defined above, X-rays produce breaks in the chromosome threads; when the resulting fragments join together in novel combinations, so-called chromosome rearrangements, hereditary changes closely resembling mutations may be produced. Rules connecting quantity and quality of radiation with type and frequency of mutations were discovered, and inferences could be drawn on number of ionizations required, size of the sensitive gene volume, etc. (*10*). Yet the actual processes of gene mutation and chromosome breakage—if indeed these are essentially different from one another—are still as mysterious as ever.

X-rays are destructive and nondiscriminating. It is conceivable that less severe methods of producing mutations might make possible a closer insight into the processes concerned. An advance in this direction was made when it was found that ultraviolet light, too, is capable of producing mutations. The restriction of the effective wave length to a comparatively narrow range which includes the absorption bands of nucleic acid and certain protein components supported the hypothesis, put forward by radiation geneticists, that the first step toward the production of a mutation consists in the absorption of an energy quantum by some constituent of the chromosome. But the hope that more specific effects, dependent on the wave length, might be produced, was not realized. Certain differences between the action of ultraviolet and that of the much shorter waves of X- and gamma rays are not yet understood, but may eventually prove helpful in the analysis of the mutation process (*18*).

Chemical substances with mutagenic properties should be particularly useful tools for attacking the problems of mutation. If, as we assume, a mutation is a chemical process, then knowledge of the reagents capable of initiating this process should throw light not only on the reaction itself, but also on the nature of the gene, the other partner in the reaction. Moreover, it could be hoped that among chemical mutagens there might be some with particular affinities for individual genes. Detection of such substances not only would be of high theoretical interest but would also open up the long-sought-for way to the production of directed mutations.

The search for chemical mutagens has been going on for well over 20 years. The choice of substances tried for the purpose was mainly random. Iodine, ammonia, metal compounds, and carcinogens are only some out of the great number tested. Results were often clearly negative, and no clearly positive ones had been obtained up to the beginning of our experiments in 1940 (see *1*, *9*, *19*). It is obvious that a chemical mutagen must possess very special properties. It must be able to act selectively on the genic material without at the same time destroying the cell which contains this material. It was, therefore, only to be expected that many substances would have to be tried before an effective one was found, and the search was continued by many workers. This search was encouraged by the accumulation of data which pointed to an influence of physiological conditions, such as age (*13*), sex (*1*), starvation (*15*), and of the genotype itself (*5*, *11*, *16*) on mutation rate. If, thus, chemical conditions created by the organism itself are capable of influencing the process of mutation, it did not seem beyond hope that chemical substances introduced from outside might have similar effects.

The choice of mustard gas for trials of this kind was suggested by observations pointing to its interference with cell division. Mustard gas burns, like X-rays burns, heal only with difficulty, and even after they appear to have healed they have a tendency to break down again. In addition, it was found that vaginal epithelium of an ovariectomized mouse which has been exposed to a weak solution of mustard gas fails to manifest the mitotic activity which normally follows stimulation with estrogens, and that this inhibition of mitosis lasts for several weeks after the exposure to mustard gas. It is well known that the chromosome breaks and rearrangements caused by X-radiation interfere with cell proliferation, partly through mechanical disturbances of mitosis and partly through death of those cells which, after distribution of the fragments and new chromosome combinations into the daughter cells, do not receive a sufficiently normal set of chromosomes. It was thought possible that mustard gas, like X-rays, may inhibit cell division through direct action on the chromosomes.

In the autumn of 1940, experiments were started to find out whether mustard gas is capable of producing gene mutations and chromosome rearrangements. *Drosophila melanogaster* was used as test animal. The flies were exposed to mustard gas vapor, first in a closed chamber and later in a container through which air mixed with mustard gas was sucked. The first results immediately gave promise of success. Both males and females became sterilized to a degree which depended on the dose. Sterility was found to be due to two independent causes, both of which are also known to be involved in the production of X-ray sterility. First, gametogenesis is inhibited, so that after a time no more ova and spermatozoa are available. Second, lethality is high among zygotes from treated eggs and, more important still, among eggs laid by untreated females which have been mated to treated males. Since the spermatozoa do not lose their motility as a result of the treatment, the most likely explanation was that mustard gas, like X-rays, produces chromosome breaks and rearrangements in the sperm.

In order to obtain conclusive proof that mustard gas exerts an action on the chromosomes, genetic methods for the detection of mutations were applied. Male flies were mated to untreated females, and the progeny (F_1) was examined for the occurrence of mutations. Early mutation work, as well as some more recent work on organisms which are genetically less thoroughly known than *Drosophila*, has suffered from the impossibility of eliminating the large personal error, for a trained worker may spot abnormalities which may pass unnoticed by a less experienced or less observant person. In *Drosophila* genetics this obstacle has been removed by methods which, in the main, have been designed by H. J. Muller, and without which the quantitative analysis of genetic radiation effects would have been impossible. The essential feature of these methods is their restriction to the detection of so-called lethal mutations, *i.e* mutations which are so harmful that they prevent development of the individual. Hence, lethal mutations are detected by the absence from the progeny of a whole class of flies, and since presence or absence are characteristics about which any two observers are likely to agree, these methods reduce the personal error to a minimum, while at the same time allowing the study of large samples without excessive labor. Particularly useful for large-scale tests are methods like the famous *ClB* test which are designed to detect sex-linked lethals, *i.e.* lethals on the sex chromosome, of which the male has only one, while the female has two. A sex-linked lethal prevents the development of a male carrying it, while it usually does not interfere seriously with development of the female. In the *ClB* test each treated or control sex-chromosome becomes subsequently represented, in the F_2, by a whole culture of flies, and if a lethal has arisen on a sex-chromosome, the corresponding culture will consist entirely of females—a fact which is, of course, readily observed even by an untrained person.

The result of the first *ClB* test with mustard gas, carried out in April 1941, was spectacular beyond expectation. Whereas the rate at which sex-linked lethals arise spontaneously in laboratory stocks rarely approaches ½ per cent, 90 lethals were found in about 1,300 treated sex-chromosomes. This represents a mutation rate of over 7 per cent. Only 3 sex-linked lethals were found in an equivalent number of untreated chromosomes, representing a rate of 0.2 per cent. Similar results had previously been obtained only with X-rays or other high-energy radiation. Further tests fully confirmed and even exceeded the first success, up to 24 per cent lethals being produced. Higher percentages can hardly be expected because, concomitantly with the increase in mutation rate, sterility becomes more and more severe.

Genetic analysis of the lethals produced in the first *ClB* test indicated that some of them were due to, or combined with, chromosome rearrangements, and these findings were confirmed by cytological examination carried out by Dr. Slizynski. A special test for the production of chromosome rearrangements by mustard gas was undertaken in December 1941. The method was designed to spot translocations, *i.e* rearrangements through which two chromosomes have exchanged portions with one another. Spontaneous translocations are so exceedingly rare that the use of controls was not considered necessary. The result left no doubt about the capacity of mustard gas to produce chromosome rearrangements; 7 translocations were found in 816 treated nuclei. A report on these results was sent to the Ministry of Supply in March 1942, but, like all this work, could not be published because of the security ban on work with war gases. In subsequent experiments more translocations as well as other types of rearrangements were produced. Since only *Drosophila* had been used for all these studies, it was gratifying that cytological investigations on pollen mother cells of *Tradescantia*, carried out by Dr. Koller in 1943, fully confirmed our finding that mustard gas can produce chromosome breaks and rearrangements.

The similarity between the genetic effects of mustard gas and of X-rays are so striking that only gradually did certain differences between the two types of action come to light. Yet special interest attaches just to these differences, because a comparison between chemical and physical mutagens seems a hopeful approach to the problem of mutation. The first difference appeared in work on translocations. It has been shown that the frequencies of X-ray-induced lethals, on the one hand, and of X-ray-induced translocations, on the other, bear a mathematical relationship to the dose administered, the first increasing directly as the dose, the second approximately as its 3/2th power (*10*). Consequently, for a given dose of X-rays (as measured in roentgen units) there exists a numerical relationship between the numbers of lethals and translocations produced. Thus, a dose of 3,000 r-units produces about 9 per cent sex-linked lethals and about 6 per cent translocations between chromosomes II and III of *D. melanogaster*. After mustard gas treatment, this relationship is shifted very markedly in favor of sex-linked lethals. Instead of the expected 6 per cent, only 0.5 per cent translocations between chromosomes II and III were produced in an experiment in which the rate of sex-linked lethals was 9 per cent, and a similar relative shortage of translocations was observed in subsequent tests. At first sight, these observations seem to indicate that mustard gas is less efficient than X-rays in breaking the chromosome thread. However, it is well to be cautious in drawing this conclusion. It has to be kept in mind that with the methods used we could not detect the primary breaks, but only a proportion of the subsequently formed rearrangements. It is conceivable that chemical treatment interferes with the process of rejoining of broken ends in such a way that a given number of breaks results in fewer observable rearrangements than would be formed by the same number of X-ray breaks. Special tests are required to decide this point.

On the other hand, mustard gas does not seem to be less efficient than X-rays in the production of very small, so-called "minute" rearrangements. Slizynski and Slizynska (*17*), in a cytological of sex-linked lethals produced by various agencies, have found that in about 20 per cent of cases the genetic change underlying the production of a lethal is a minute deficiency in the chromosome, and this frequency appears to be the same after X-rays, after ultraviolet radiation, and after mustard gas treatment. These findings emphasize the similarity, often pointed out by geneticists, between true gene mutations and minute chromosome rearrangements, and they do not contradict the possibility that so-called gene mutations may be nothing more than chromosome rearrangements of so minute a size that they elude detection by cytological methods. It will be of great interest to determine whether small deficiencies form an equally high proportion of lethals which have been produced by less potent chemical substances than mustard gas.

A second difference between the actions of X-rays and of mustard gas came to light in the course of a study of visible mutations after chemical treatment. In one respect this study was disappointing since the mutations observed were of the same types as those found after X-ray treatment, and there was no indication of any specific effects of the gas on individual genes. Mustard gas seems to act as indiscriminately as X-radiation. There is, however, a difference between these two agencies which involves not the types of mutation which they produce, but the way in which the mutations become manifest in the offspring of the treated flies. After X-ray treatment of males most of the mutated offspring show the induced abnormality (such as yellow body color instead of the normal gray) over the whole surface of their body. Only a small proportion (less than 15 per cent) of the mutated individuals are mosaics, *i.e.* show the abnormality in a part of their body, the remainder being normal. In the progeny of mustard-gas-treated males, on the other hand, mosaics form a high proportion (usually between 30 and 50 per cent) of all mutated individuals (*2*). Moreover, whereas the gonads of X-ray mosaics rarely contain both normal and mutated cells, those of mustard gas mosaics quite frequently appear to do so. A special study has been made of such "gonadic mosaicism" with respect to sex-linked lethal mutations (*3*). A female, daughter of a treated male, whose ovaries contain a patch of tissue in which the cells carry a sex-linked lethal, will have fewer sons than a normal female, the shortage of sons depending on the relative sizes of the normal and mutated portions of the ovary. A similar depression of the sex ratio occurs also in the progeny of females who carry, evenly distributed through all cells of their ovaries, a sex-linked "semilethal" mutation, *i.e.* a mutation which weakens the males so that only a proportion of them are capable of completing development. Analysis of females giving a low sex ratio has shown that among daughters of irradiated males this abnormality is almost always due to a semilethal mutation affecting the whole of the ovary. On the other hand, in 9 out of 20 daughters of mustard-gas-treated males, the shortage of sons was due to the presence in their otherwise normal ovaries of a mosaic patch carrying a sex-linked lethal. Finally, mention should also be made of a striking case of mosaicism in which a son of a mustard-gas-treated male was, both in the gonads and in the soma, a mosiac for two different mutations of the same gene, although it must be assumed that in the treated spermatozoon each treated gene was present only once.

An explanation which seems particularly satisfactory in accounting for all these observations is that the gene affected by treatment does not always mutate at once, but may acquire a tendency to mutate which remains latent until a later cell division. Support for this hypothesis was obtained when it was found in several cases that the offspring of gonadic mosaics for a mutation again were gonadic mosaics for the same mutation. In these cases an induced specific instability seems to have been transmitted from one generation to the next before giving rise to a stable change. No parallel observations have been reported in literature on radiation genetics; but it seems worth noting that so-called "unstable" genes, *i.e.* genes which tend to mutate repeatedly in the same direction, have been found several times in untreated material (*6*).

The difference between the mutations produced by short-wave radiation and chemical reaction may be tentatively ascribed to the different amounts of energy involved in the two types of reaction. In short-wave radiation the energy made available is usually sufficiently large to produce a catastrophic alteration in the structure of the gene, by transforming it from one stable configuration to another. On the other hand, reaction of the gene with a chemical substance, because of the smaller amount of energy involved, may produce a less drastic effect, by transforming it to an intermediate metastable configuration. Such a configuration will, of course, tend to undergo "spontaneous" alteration to another and more stable configuration, *i.e.* an "unstable" gene is produced.

After the first positive results with mustard gas had been obtained, the search for chemical mutagens was extended to substances which either in their chemical structure or in their pharmacological action are related to mustard gas. Mustard gas is a fixative of protoplasm with unusual power of penetration. It was soon seen that these two properties by themselves are not sufficient to make a substance mutagenic, for neither osmic acid nor picric acid affected the mutation rate in tests in which the majority of the treated individuals were killed. Neither can it be said that every potent vesicant is a mutagen, for lewisite gave entirely negative results in two *ClB* tests. So far only three substances have been found which give genetic effects similar to those of mustard gas. These all belong to the class of nitrogen- or sulphur-mustards. Their chemical formulas are: (1) $O(CH_2 \cdot CH_2 \cdot S \cdot CH_2 \cdot CH_2Cl)_2$, (2) $N(CH_2 \cdot CH_2Cl)_3$, and (3) $CH_3 \cdot N(CH_2 \cdot CH_2Cl)_2$.

As the chemical mutagens presumably attack the genic material directly, it was noted with interest that these active compounds all contain an unsaturated atom (:S or ⁝N) which might combine with materials composing the gene, and that this activity would be enhanced by the type of side chains present in the vesicant mustards (e.g. $ClCH_2 \cdot CH_2$-). With this type of structure is associated the tendency to intramolecular cyclization to form onium compounds (*7*), characteristic of the active ⁝N and :S vesicants. Assuming that the mutagenic action is due to the reaction on the unsaturated atom of the uncyclized compound with the gene, it was thought likely that replacement of the :S and ⁝N by :O would not produce active materials, as the addition compounds of divalent oxygen are not stable in aqueous solution (and "O mustard" is not a vesicant). Stable addition compounds are, however, formed by compounds having the :CO group, and though the corresponding "CO mustards" were not tried, the tear gases, chloracetone and dichloracetone (compounds with $ClCH_2$- side chains instead of the $ClCH_2 \cdot CH_2$- of mustard gas) were examined. The activity of these compounds was extremely weak; in fact, the results were not clearly positive, although they suggest the possibility that both these compounds are slightly mutagenic. By analogy with the vesicant action of the :S compounds, the chlorethylacetones might be more active. It has not yet been possible to test these substances.

Other groups which might replace the :S and ⁝N of the mustards and retain the additive ability of the molecule include ⁝As, although compounds with ⁝As are rather unstable under physiological conditions and are mostly toxic. The corresponding ⁝P compounds are apparently out of the question in this connection, as they are spontaneously inflammable in air. The $:SO_2$ compounds may similarly be expected to show some activity, but not the :SO ones. This parallels their vesicant action. There is also the possibility of using nitrile, isonitrile, and the corresponding thiocyanates and isothiocyanates for the coordinating group, and attention was therefore directed to allyl isothiocyanate. A weak but definite mutagenic activity could be demonstrated for this compound (*4*).

On the other hand, this type of chemical structure does not seem a necessary prerequisite for a mutagenic substance. This is shown by the fact that Hadorn and Niggli (*8*) have obtained considerable numbers of mutations by exposing explanted ovaries of *Drosophila* to weak solutions of phenol.

Allyl isothiocyanate, or mustard oil, occurs naturally in plants of the genus *Brassica*. We do not know whether it acts as a mutagen in these plants, but it is interesting to speculate how far naturally occurring mutagens may be responsible for spontaneous mutability. It has been shown by Muller and Mott-Smith (*14*) that cosmic radiation and natural radioactivity are quantitatively insufficient to account for the observed rates of spontaneous mutation. Timoféeff-Ressovsky, Zimmer, and Delbrück (*20*) have suggested that random temperature oscillations inside the nucleus may occasionally overstep the energy threshold required for the production of a mutation. In the light of the results reported here it seems possible, however, that a certain proportion of natural mutations may be due to the action of mutagenic substances within the organism, and whose production may itself be the consequence of gene action. Such an assumption finds support in the known cases in which definite genes influence mutability of the rest of the genes or even of a specific gene (*2*, *11*, *17*). Search for natural mutagens is therefore of high interest, but may well turn out to be exceedingly difficult. By its very nature a natural mutagen can have no drastic effect in the species in which it occurs; otherwise, the species could not survive. Moreover, a physiological system which includes mutagens whose production is controlled by genes will, in the course of its evolution, have attained a finely attuned equilibrium between the strength of the effective substances and the sensitivity of the gene or genes on which they act. Removed from its normal genotypical environment, a natural mutagen may produce quite different effects or none at all. Therefore, results obtained with one organism may not be transferable to another, in contrast to results gained with such drastic agencies as X-rays and, presumably, mustard gas. Nevertheless, it is tempting to consider the possibility that one of the means by which evolution adapts mutability to environmental requirements is the achievement of a balance between the production of mutagens and sensitivity to them.

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Obituary

Henry Helm Clayton

1861–1946

With the passing of Henry Helm Clayton, on October 26, 1946, there ended a life of exceptional activity and eminence in meteorology, public service, and business.

Clayton was born on March 12, 1861, at Murfreesboro, Tennessee. Because of delicate health, early education was acquired in private schools and by study at home. It was during this period that his interest in meteorology developed.

Studies of local storms, beginning in 1878, were followed in 1882 by his first activity, aid in the organization of the newly formed Tennessee Weather Service, including analyses of reports and a gift of 30 rain gauges. In 1884–85 he was assistant at the Observatory of the University of Michigan and associate editor of the *American Meteorological Journal*. In February 1886, after three months at Harvard College Observatory, he joined the staff of Blue Hill Meteorological Observatory, founded by Abbott Lawrence Rotch in the preceding year, where he remained as assistant and meteorologist until 1909. During this period many important advances were initiated by him with the enthusiastic approval of Director Rotch. At first there was no assistant, and at various times, at his own expense, Clayton employed others to share his rapidly expanding program of research.

Clayton's studies of clouds, begun in 1886, yielded the first definite information concerning the circulation of the atmosphere over America and established the Clayton-Egnell law of the increase of velocity with height. The detailed observations during the period 1886–90 are the only hourly data of changes in form, height, and movement of clouds in the Western Hemisphere, and, with Clayton's discussion, undoubtedly stimulated the organization of the International Cloud Committee and the international series of measurements of heights and velocities of 1896. The colored pictures for the *Atlas of clouds*, issued in 1897 by the U. S. Hydrographic Office, were painted under Clayton's supervision. He was also consultant in the preparation of the first *International atlas* (1905).

Clayton's invitation to William A. Eddy to try his meteorological kites at Blue Hill led to the first use of kites to lift recording instruments, August 4, 1894, and to the adoption throughout the world of this method of sounding the atmosphere. Important results of Clayton's analyses of the accurate data obtained included the discovery of persistent, sharply defined stratifications in the lower atmosphere, and previously unsuspected, variable effects of mountains upon the surrounding atmosphere. Interest in this new method of research, later to be named "aerology," is indicated by his generosity in allowing free use in aerology, without royalty, of the form of Hargrave kite patented by him, which came into use at all aeronautical laboratories. Always envisaging improved techniques and advances in aerology, he encouraged Blue Hill to develop the first radio sonde, in 1935.

He described the solar eclipse as "a kind of laboratory experiment in which are eliminated practically all influences upon the atmosphere except that of a fall of temperature," and original studies led to his suggestion of the eclipse cyclone caused by the cooling of the air by the shadow.

Clayton's great interest in forecasting was first indicated by his paper, "A lately-discovered meteorological cycle," published in the *American Meteorological Journal* in August 1884. Later, at Blue Hill, his proof that forecasts made locally are better than those issued at a distant central office caused the authorization of local forecasting at principal stations of the government weather service. An important public service at this time was his strongly supported effort toward removal of the national weather service to a civilian department, followed by action by Congress in 1891. He was local forecast official in the new Bureau, 1891–93, and in the *Blue Hill Weather Bulletin* of 1896–97, he published weekly forecasts based upon cycles. In 1910 he was invited to Argentina, where he was chief of the Forecast Service for nine years. There he inaugurated forecasting based upon variations in solar energy. On his return to the United States, Clayton continued this work in cooperation with the Smithsonian Institution and, starting a private weather service, forecasted and acted as consultant for business organizations while prosecuting his researches. At the beginning of World War II, the Government suspended private forecasting, but, during 1943–44, at the request of the Weather Bureau, he continued research on an extended scale to determine the relations between short-period changes of solar energy and variations of weather. This work, done through Harvard University, was aided by a statistical group maintained by the Weather Bureau.

Clayton's many studies of solar relations in cooperation with the Smithsonian Institution led to *World weather records*, a notable contribution to meteorology and climatology published by the Institution and highly praised by the International Meteorological Organization; the third volume is now in press. His researches were summarized in *World weather* (Macmillan, 1923) and in *Solar relations to weather* (Clayton Weather Service, 1943). A monograph amplifying earlier studies of the possible effects of the planets on solar variations, and of cycles, especially in their biological relationships, was completed only a month before his death.

In 1905 he headed the deBort-Rotch expedition for exploring the atmosphere over the Atlantic Ocean with kites and balloons. With Director Rotch, he represented Blue Hill at the International Meteorological Conference at Munich in 1891, and was delegate from Argentina to the first Pan-American Scientific Congress at Washington in 1915 and the Sixth International Meteorological Conference at Utrecht in 1923. In 1943 he was awarded a gold medal by the Foundation for the Study of Cycles. He was a charter member of the American Meteorological Society.

Clayton possessed the unusual combination of a vivid imagination, an ability to visualize atmospheric phenomena in their three dimensions, exceptional industry, steadfastness of purpose, and a keen sense of values. Throughout his life he was a pioneer, with all the courage and energy necessary to open new paths in spite of difficulties and hard knocks. Yet he was unassuming, warm and gracious in his manner, and always ready to concede values in points of view differing from his own.

STERLING P. FERGUSSON and
CHARLES F. BROOKS

Blue Hill Meteorological Observatory,
Harvard University

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NEWS *and Notes*

Edmund E. Day, president of Cornell University and chairman of the Inter-Society Committee on Science Legislation created at the instigation of AAAS, appeared by invitation before the Interstate and Foreign Commerce Committee of the House of Representatives on March 6. The other members of the Executive Committee of the new group—Harlow Shapley, vice-chairman; Dael Wolfle, secretary-treasurer; R. G. Gustavson, chancellor, University of Nebraska; Ralph W. Gerard, University of Chicago; and Douglas M. Whitaker, Stanford University—also attended the hearings after holding the first meeting of the Executive Committee on March 5.

In presenting the opinion of the Inter-Society Committee, Chairman Day said in part:

> . . . We need a National Science Foundation to help provide facilities and to help train scientific workers to use them.
>
> There is no thought that a National Science Foundation will interfere with the excellent work being done by the private foundations and institutions, or the government agencies that are now active in research.
>
> The private foundations, for a long time the major source of support for basic research and scholarships, welcome the relief provided their inadequate resources and have gone on record saying so.
>
> The private colleges and universities as Dr. Conant, among others, has said, see no spectre of government control in accepting money for research and scholarships (*Science*, January 3). The research agencies in the government see the new Foundation as supplementing their restricted efforts. . . .
>
> These views led to the introduction into the 79th Congress of two Science Foundation bills in the House of Representatives, H.R. 6448 by Representative Mills and H.R. 6672 by Representative Celler. Several bills were introduced into the Senate which were eventually combined in S. 1850, the Senate counterpart of the Celler bill. The Senate passed this bill (*Science*, May 10, 1946).
>
> In July 1946 the House Committee on Interstate and Foreign Commerce considered the two bills, but in view of the many honest differences of opinion over details of these bills, wisely decided to defer action in order to allow fuller discussion of so important a matter in the 80th Congress (*Science*, July 26 and August 2, 1946).
>
> That action allowed scientists themselves, and members of Congress, an opportunity to discuss and to consider the characteristics of a bill which will create the most effective National Science Foundation. The Inter-Society Committee of scientists, which I represent, was formed for the purpose of ascertaining, coordinating, and reporting the attitudes of American scientists toward the various issues involved in the creation of a National Science Foundation. The Committee held its first meeting in Washington on February 23.
>
> There was complete unanimity at that meeting on the very great importance of establishing a National Science Foundation. The large attendance, the wide range of scientific societies represented, and the high competence of the scientists who attended were impressive proof of the importance given to securing effective action on the problem. . . .
>
> The issue before this Committee is so important that we urge more extended study and further consideration of these bills. We expect to prepare a more definitive statement which will represent the best judgment of scientific opinion. We would like an opportunity to present it before this Committee at a later time.

About People

Harlow B. Mills, professor and head, Department of Zoology and Entomology, Montana State College, has been appointed chief, Illinois State Natural History Survey, to succeed the late Theodore H. Frison. Dr. Mills will assume his duties March 1.

Charles William Huntley, dean of Adelbert College, Western Reserve University, Cleveland, Ohio, became dean of Union College, Schenectady, New York, February 1, succeeding Charles F. F. Garis, who retired after 44 years at the college. Dr. Huntley, a psychologist, was a former student of Dr. Garis.

Lewis Hanford Tiffany, William Deering professor of botany and chairman, Department of Botany, Northwestern University, has been appointed to the Illinois State Board of Natural Resources and Conservation to succeed E. J. Kraus, University of Chicago.

Harold Schlosberg, Department of Psychology, Brown University, has been promoted to the rank of full professor. Prof. Schlosberg, who this past year has set up laboratory facilities for a new Distribution course in psychology, during the war wrote the monthly "Psychology News Letter" for distribution to foreign scientists by the Office of War Information.

William A. Hamor, Mellon Institute of Industrial Research, University of Pittsburgh, received the honorary LL.D. degree at the commencement of the University of Miami, Coral Gables, Florida, January 30.

Freeman S. Howlett has been made professor and acting chairman of the Department of Horticulture and Forestry, Ohio State University, Columbus, Ohio.

Chester Peterson, former director of the Inspection Division, Philadelphia Signal Corps Procurement District, has been appointed physicist in the Resistance Measurements Section, National Bureau of Standards. He will work with other members of the Bureau Staff on completion of an Absolute Measurement of Resistance, investigation of which was interrupted by the war.

Byron T. Shaw has been appointed assistant administrator of agricultural research, U. S. Department of Agriculture, to succeed W. V. Lambert, who became administrator last October. Dr. Shaw, a soils physicist, has been in charge of research in this subject in the Bureau of Plant Industry, Soils, and Agricultural Engineering since 1943. His new appointment begins March 10.

J. McDunnough, recently retired chief of the Systematic Unit, Division of Entomology, Canadian Department of Agriculture, has accepted a research associateship at the American Museum of Natural History, New York City, where he will continue studies on North American Lepidoptera.

Robert E. Campbell, Lt., Chemical Corps, has been made chief meteorologist for the Test Division, Technical Command, Edgewood Arsenal, Maryland.

F. L. Wynd, formerly of the University of Illinois, has been appointed professor of plant physiology and biochemistry at Michigan State College, East Lansing, and head of the Department of Botany and Plant Pathology to succeed E. A. Bessey.

George M. Stanley, associate professor of geology, University of Michigan, has been granted a sabbatical leave of absence for the university year 1947–48 to conduct research on the shorelines of extinct Pleistocene Lake Lahonton in western Nevada to determine recent crustal movements among the mountain ranges and intermontane basins occupied by various arms of this former large body of water. A similar study may be undertaken around Yellowstone Lake.

Paul S. Nicholes, formerly with the U. S. Biological Warfare Division, Camp Detrick, Maryland, has been named assistant professor of bacteriology, University of Utah School of Medicine, Salt Lake City, to replace W. E. Clapper, who recently accepted a position at the University of Colorado School of Medicine.

Visitors to U. S.

Australian scientists visiting this country include: S. M. Sykes, research officer, Division of Horticulture, New South Wales Department of Agriculture, who will attend the convention of the National Association of Frozen Food Packers to be held in San Francisco and will remain in this country about six months to study fruit and vegetable freezing; D. R. Ziedler, senior research officer, Division of Industrial Chemistry, Australian Council for Scientific and Industrial Research, who is spending several months at the Chemical Engineering Department, Massachusetts Institute of Technology; N. A. Esserman, chief, Division of Metrology, National Standards Laboratory, Sydney, Australia; and Ian Langlands, officer in charge of the Building Materials Research Division, Australian Council for Scientific and Industrial Research, who expects to remain in the United States for two months.

All of the above may be contacted through the British Commonwealth Scientific Office, Room 505, 1785 Massachusetts Avenue, N. W., Washington 6, D. C. (Attention: Mrs. V. Connell.)

B. Wasserstein, senior mineralogist, Geological Survey of the Union of South Africa, on study-leave in the United States, is taking courses at Massachusetts Institute of Technology, Cambridge, Massachusetts.

Kathleen Lonsdale, Royal Institution and University College, London, is conducting research at the National Institute of Health, Bethesda, Maryland, under a special research fellowship until the end of July. Dr. Lonsdale, one of the first two women elected to Fellowship of the Royal Society, will be at the California Institute of Technology during March. She is available to lecture on her work in X-ray crystallography while in this country.

Grants and Awards

The 11th Oberly Memorial Award, given by the University of South Carolina every two years for the outstanding bibliography in the field of agriculture or related sciences, will be made in the spring of 1947. Persons interested in competing for the prize should send four copies of their bibliography to W. P. Kellam, Chairman, Oberly Award Committee, University of South Carolina, Columbia.

The University of Illinois has accepted a grant of $6,400 a year for five to six years from the Herman Frasch Foundation, New York City, for investigating possibilities of increasing organic matter of soils under practical crop conditions and determining the role of organic matter in production of exceptionally high yields of corn and other crops.

Investigation will be conducted in the Soil Fertility Division, Department of Agronomy, under Roger H. Bray, Ernest E. DeTurk, and O. H. Sears.

Lyla Tupper Bradin is recipient of a $1,200 Ciba grant-in-aid to the Department of Biology, Johns Hopkins University, and the Department of Embryology, Carnegie Institution of Washington. The grant is to aid in a study of fetal maturity at birth as related to the maternal uterine environment before birth, with special reference to sensitivity of the respiratory center to anoxia and respiratory stimulant drugs.

The University of Texas Medical Branch, Galveston, has received an initial grant of $500 from J. B. Nail and alumni associates of Wichita Falls, Texas, for establishment of a research fund for the study of deafness. Dr. Nail indicated that the alumni of the Wichita Falls area will maintain this research fund by annual grants.

Western Reserve University has been granted $112,000 by the National Foundation for Infantile Paralysis to finance a five-year study of the effect of the polio virus on nerve and brain tissue. The following members of the Department of Biochemistry, School of Medicine, will participate: Harland G. Wood, head of the Department; Merton F. Utter, associate professor; John A. Muntz and Thomas P. Singer, assistant professors; and G. Robert Greenberg, instructor. These men will work with mice and cotton rats which have been infected by the Lansing strain of the polio virus.

Colleges and Universities

The University of Michigan has appointed Robert Travers, chief examiner, and Clyde Coombs, research psychologist, in the Bureau of Psychological Services, Institute for Human Adjustment, effective February 1.

The Utah State Agricultural College, Logan, Utah, has appointed E. L. Waldee, associate professor of plant pathology, and R. K. Gerber, assistant professor of horticulture. Dr. Waldee was on the staff of Iowa State College before entering the service, and Mr. Gerber had done government research in plant pathology.

The Department of Botany and Plant Pathology, Michigan State College, East Lansing, announces the following recent appointments: C. J. Alexopoulos, formerly deputy director of UNRRA in Greece, associate professor of mycology; W. B. Drew, University of Missouri, associate professor of ecology and taxonomy; G. W. Prescott, Albion College, associate professor of morphology and phycology; G. P. Steinbauer, University of Maine, associate professor of physiology and biochemistry; L. C.

Knorr, Cornell University, assistant professor of plant pathology; R. Lowry, University of Michigan, assistant professor of cytology and genetics; P. W. Dennis, Independence Junior College, assistant professor of botany; and J. Elliott, Coldwater, Michigan, High School, instructor of botany.

Summer Programs

The Mount Desert Island Biological Laboratory, Salsbury Cove, Maine, is inaugurating a new summer laboratory for study of problems in aseptic cultivation and nutrition of organisms and tissues. The laboratory, for independent investigators and advanced students, will be under Philip R. White, general physiologist, Institute for Cancer Research, Philadelphia.

Some of the problems now visualized are in vitro cultivation of invertebrate and vertebrate tissues; meristematic tissues of algae, mosses, ferns, and spermatophytes; excised embryos of ferns, mosses, marine algae, and flowering plants; embryonic stages of invertebrate animals such as the brine shrimp and of carnivorous invertebrates such as hydroids; and slime molds. Questions of nutrition, and control and manipulation of morphogenesis will have an important place in the studies.

The fee will be $100 for the season extending from June 15 to September 15 or for any part of the season. Applications should be sent to Philip R. White Institute for Cancer Research, Girard and Corinthian Avenues, Philadelphia 30, before March 15.

Meetings

The Centennial Celebration of the New York Academy of Medicine was inaugurated March 6 with a dinner at the Waldorf-Astoria Hotel at which John A. Ryle, professor of social medicine, Oxford University, England, gave the principal address, "Social Pathology and the New Era in Medicine." William O'Dwyer, mayor of the city of New York, and George Baehr, president of the Academy, also spoke.

Throughout the celebration a series of meetings and conferences will be held by sections of the Academy and affiliated organizations, and a number of exhibitions will be placed on view. The following five Institutes will also be held: Library Methods and Problems, March 11–12; Social Medicine, March 19–21; Public Health, April 1–3; Medical Education, April 16–18; and Hospitals, April 21–23.

All meetings except the first day of the New York Academy of Sciences Conference, March 21, will be held at the Academy of Medicine Building, 2 East 103rd Street, New York. Exhibits will be at the Academy building, Metropolitan Museum of Art, New York Historical Society, Museum of the City of New York, and the New York Public Library.

Elections

The California Academy of Sciences has elected the following men as Fellows in recognition of distinction in scientific work: L. H. Brown, G. F. Ferris, J. W. MacBain, and C. B. van Niel, Stanford University; F. A. Jenkins, Harold Kirby, and E. G. Linsley, University of California, Berkeley; Peter Frendsen, University of Nevada; H. U. Sverdrup, director, Scripps Institution of Oceanography; and S. B. Show, who recently resigned as regional forester of the Forest Service, San Francisco, to accept a post with UNESCO.

The American Astronomical Society has elected the following foreign astronomers to honorary membership in the Society: Megh Nad Saha, University of Calcutta, India; Gavriil A. Tikhov, U.S.S.R.; Bertil Lindblad, Stockholm Observatory, Saltsjobaden, Sweden; Jan H. Oort, Sterrewacht, Leiden, Netherlands; E. A. Milne, Oxford, England; and Bernard Lyot, Observatoire de Meudon, France.

Recent Deaths

Sir John Flett, 77, director of the Geological Survey of Great Britain and the Museum of Practical Geology between 1920 and 1935, died January 26.

Kurt Lewin, 56, director of the Research Center of Group Dynamics, Department of Economics and Social Sciences, Massachusetts Institute of Technology, died February 12 at Cambridge, Massachusetts. He was formerly professor of child psychology at the Child Welfare Research Station, University of Iowa, Iowa City.

Walter Ivan Lillie, 55, head of the Department of Ophthalmology, Temple University Medical School, died February 21 in Philadelphia.

Henry Beaumont, professor of psychology and director of the Bureau of Industrial Psychology, University of Kentucky, died at his home in Lexington February 21.

Horace A. Shonle, 55, director, Organic Chemistry Division, Eli Lilly and Company, died February 24 after a brief illness from pneumonia.

NRC News

A grant of $10,000 has been received from the Viking Fund to aid anthropological research in the Pacific area under the Pacific Science Board of the NRC. The Board, in cooperation with the Council's Pacific Committee on the Anthropological Sciences and the Navy Department, is engaged in developing plans for a coordinated program of anthropological and associated research in Micronesia. The Council has also received a grant of $5,000 from the Coolidge Foundation for the general fund of the Pacific Science Board.

Make Plans for—

Crystallographic Society, 2nd annual meeting, March 19–21, U. S. Naval Academy, Annapolis, Maryland.

Western Metal Congress and Exposition, fifth, March 22–27, Civic Auditoriums, Oakland, California.

World Health Organization Interim Commission, March 31, Geneva, Switzerland.

Midwest Power Conference, March 31–April 2, Palmer House, Chicago.

American Association of Anatomists, annual meeting, April 3–5, Mount Royal Hotel, Montreal, Canada.

Institute of Mathematical Statistics, meeting on stochastic processes and noise, April 24–25, New York City.

National Academy of Sciences, annual meeting, April 28–30, Academy Building, Washington, D. C.

COMMENTS *by Readers*

Researchers can extend their work and reduce the burden of calculation if they use punch cards and tabulating machines.

As Neil R. Bartlett suggests (*Science*, October 18, 1946), many scientific workers are unfamiliar with punch-card techniques. His plan for multiplying in order to obtain the sum of X, X^2, XY, Y^2, we have used to multiply 8 four-digit numbers and summary punch the totals all at one time. These summary cards, which carry the progressive totals for the digit used as multiplier, may then be added into the grand total, which is summary punched, and thus the product sums desired are obtained without the manual work he describes.

The card method is especially valuable whenever there are many variables in the matrix to be multiplied and where the N is large.

We have expanded the use of cards into factor-analysis calculations. The centroid method has been described (D. M. Hall, E. L. Walker, and Isabelle Crawford. *Psychometrika*, June 1945), and we are now perfecting the principal factor method procedures. (D. M. Hall, *University of Illinois*.)

Chronic vitamin B_1 deprivation in litters of dogs can affect social dominance as measured by biting without retaliation, the order in which animals go to the food pan, and the relative or absolute immunity from attack by other animals in the group. There have been a number of studies demonstrating the existence of social dominance among such vertebrates as hens, mice, canaries, cattle, and dogs; and changes in dominance have been studied in connection with hormone administration, as testosterone propionate, restriction of cage space, and with social variables, as introducing a new animal into an established social group (W. C. Allee. *Biol. Symp.*, 1942, **8**, 139–162).

It was found in connection with another study in 1941 (I. A. Berg. *J. exp. Psychol.*, 1944, **34**, 343–368) that social hierarchies existed in each of five litters of puppies. In one litter of four males and one female, the least dominant animal, a male, was so severely bitten and so regularly driven from the feeding pan that he was isolated in a separate cage and given a special diet which included milk and raw beef. The other animals had earlier been placed on an exclusive diet of water, canned dog food, and a type of dry dog chow. After three weeks the isolated animal was again placed in the cage with his littermates with the result that he reversed his previous social position and became the dominant animal of the litter after several fights with each of his littermates.

About a week after this an increasing loss of appetite, followed by symptoms of "Fright Disease," was noted in those animals which had been fed for several months on the commercial dog food ration. Following the suggestion made by J. W. Patton (*Vet. Med.*, 1939, **34**, 372–381), 600 I.U. thiamine chloride were injected subcutaneously in all five animals daily for four days. Patton had noted that commercial dog foods are usually autoclaved and that B_1, being heat labile, is destroyed as a result of the autoclaving.

It is believed that the chronic B_1 deficiency resulting from the autoclaved dog food was directly related to observed changes in social dominance in this litter; for, after the series of B_1 injections, a number of fights ensued, and the previously dominant male resumed his ascendant position in the social hierarchy. The male which had originally been lowest and, after the special diet, highest in dominance ended as third highest in the social group of littermates. The female was lowest in the new hierarchy. This final order of dominance remained for almost two months, when no further observations were made. Similar dominance shifts associated with B_1 deprivation were noted in other litters.

It is suggested that investigators of social dominance and of hormonal effects on behavior take special precautions to ensure an adequate B_1 supply in the animals' diet, since, in addition to the effects noted here on dominance, testicular hypofunction or atrophy (C. H. Best and N. B. Taylor. *Physiological basis of medical practice*. 3rd ed., 1943. p. 1297), accompanied by reduced sex hormone secretion, can result from B_1 deficiency. (Irwin August Berg, *University of Illinois*.)

C. Perrier and E. Segrè (*J. Chem. Phys.*, 1937, **5**; 1938, **6**) showed that radioactive isotopes of element 43 could be formed by neutron or deuteron bombardment of molybdenum. Several chemical properties of element 43 were established at the time, as well as some nuclear properties of the spectral isotopes. These isotopes were found in nuclear bombardments by the 37-inch cyclotron of the Radiation Laboratory, University of California.

Later, C. S. Wu and E. Segrè (*Phys. Rev.*, 1940, **57**) found element 43 among the fission products of uranium, a source from which relatively large amounts of 43 can be isolated.

It seems appropriate now to give this element the name technetium, from the Greek *τεχνητός*, artificial, in recognition of the fact that technetium is the first artificially made element. The corresponding chemical symbol should be Tc.

In 1940 D. R. Corson, K. R. Mackenzie, and E. Segrè (*Phys. Rev.*, 1940, **57**) prepared the isotope of mass 211 of element 85 by bombarding bismuth with alpha particles accelerated in the 60-inch cyclotron of the Radiation Laboratory, University of California. At that time they established several chemical properties of element 85 and made a rather complete nuclear study of the isotope formed.

A name should now be given to this new element and, following the system by which the lighter halogens chlorine, bromine, and iodine have been named—by modifying a Greek adjective denoting some property of the substance in question—the discoverers propose to call element 85 astatine, from the Greek *ἄστατος*, unstable. Astatine is, in fact, the only halogen without stable isotopes. The corresponding chemical symbol proposed is At. (E. Segrè, *University of California, Berkeley*.)

Comparison of the Provisions of S. 525 and S. 526

S. 525 Compromise bill, S. 1850, as passed by the Senate, July 3, 1946	S. 526 A new measure, similar to the original Magnuson Bill, S. 1285
ORGANIZATION	
Board	*Foundation*
A National Science Board of 9 members is to be appointed by the President, by and with the advice and consent of the Senate, plus the chairmen of the several divisional scientific committees (originally 7).	The Foundation is to have 48 members appointed by the President, by and with the advice and consent of the Senate. The President is requested to give due consideration to recommendations from the National Academy of Sciences or other scientific or educational organizations.
Term of office is to be 3 years with possibility of reappointment after a lapse of 1 year.	Term of office is to be 8 years, with possibility of reappointment after a lapse of 4 years.
The Board is required to meet 6 times a year.	The Foundation is required to meet once a year or at the call of its chairman.
(In this bill the Foundation is defined as a government agency including the Board, all advisory and employed personnel.)	
Divisional Structure	*Divisional Structure*
The Foundation is to contain Divisions of: Mathematical and Physical Sciences; Biological Sciences; Health and Medical Sciences; National Defense; Engineering and Technology; Scientific Personnel and Education; Publications and Information.	The Foundation is to contain a Division of National Defense which is to report to the Foundation. Until otherwise provided by the Foundation, there shall also be Divisions of: Medical Research; Mathematical, Physical, and Engineering Sciences; Biological Sciences; Scientific Personnel and Education for the granting of all scholarships. The Foundation is empowered to enlarge the number of Divisions as necessary.
The functions of the Divisions are to be prescribed by the Administrator on the advice of the Board.	
ADMINISTRATION	
Board	*Executive Committee*
The Board is to appoint its own executive secretary whose salary is not to exceed $12,000 annually.	The Foundation is to elect biennially from its own members an Executive Committee of 9.
The Board is to elect a chairman annually from its own membership.	The Executive Committee is to choose its own chairman and vice-chairman biennially; ex-officio principal officers of the Foundation.
	The Executive Committee is required to meet 6 times a year.
	The Executive Committee is to establish advisory committees as it sees fit.
The President is to appoint an Administrator, by and with the advice of the Senate, after receiving recommendations from the Board; compensation is to be $15,000 annually.	The Executive Committee is to appoint a Director, with the approval of a majority of the Foundation, whose salary is to be $15,000 and who is to report to the Executive Committee.
	The Executive Committee is required to make an annual report to the President and Congress, making appropriate recommendations.
Administrator	*Director*
The Administrator is to appoint a Deputy at $12,000 annual compensation.	The Director may appoint a Deputy whose annual compensation must not exceed $12,000.
The Administrator is to appoint the Directors of various divisions, who are to be full-time employees at $12,000 a year.	The Director is to appoint and fix compensation of other personnel.
The Administrator is to appoint other personnel as he deems necessary and at rates he determines.	
The Administrator is required to consult with the Board and through the Directors with the divisional committees in exercising his authority.	
The Administrator is to establish advisory committees as he sees fit.	

DIVISIONAL COMMITTEES

The Division of National Defense is to be a committee of not more than 40, at least half civilians, appointed by the Administrator, the remainder divided equally between appointees of the Secretaries of War and Navy.	The Division of National Defense is to be a committee, appointed by the Foundation, of not less than 8 or more than 40. One half are to be civilians, appointed by the Foundation; the remainder, representatives designated in equal numbers by the Secretaries of War and Navy.
The Executive Committee for the Division of National Defense is to consist of 5 members: the chairman of the divisional committee, 2 civilians, and 2 officers designated by the Army and Navy, respectively. The civilians are to be elected annually by the civilian members of the divisional committee.	The Executive Committee for the Division of National Defense is to consist of 5 members: the chairman of the divisional committee, 2 civilians, and 2 designated by the Army and Navy, respectively. The civilians are to be elected annually by the civilian members of the divisional committee.
Each Division except National Defense is to consist of a scientific committee of not less than 5 or more than 15 members, appointed by the Administrator with the advice and approval of the Board.	Each Division except National Defense is to consist of a scientific committee of not less than 5 members appointed by the Foundation.
The members of the divisional committees are to serve 3-year terms.	The term of each member is to be fixed by the appointing authority.
Each divisional committee is to elect its own chairman from among its own members.	Each divisional committee is to elect its own chairman from among its own members.
Each divisional committee is required to meet at least 6 times a year.	

EXPENDITURE OF FUNDS

Of the available funds, a minimum of 15 per cent is to be allocated to National Defense, and a minimum of 15 per cent to the Division of Health and Medical Sciences.	No specific provision is made for the distribution of research funds allotted to the Foundation.
A minimum of 25 per cent of all funds (exclusive of those for National Defense) is to be distributed on a geographic and population basis among the states. These amounts are to be expended only for research and development activities in tax-supported colleges and universities, including land-grant colleges.	
An additional amount of not less than 25 per cent may be expended in nonprofit organizations.	
Activities of the Foundation shall only supplement those of other government agencies authorized to do scientific research and development.	

APPOINTMENT OF PERSONNEL

The Administrator is to have the authority to waive the usual civil-service regulations covering employees.	The Director is to have the authority to waive the usual civil-service regulations covering employees.
	The Deputy Director is specifically exempt from civil-service rules.

PUBLICATION

Provision is made for full dissemination of scientific and technical information consistent with national security.	Provision is made for full dissemination of scientific and technical information consistent with national security.

SCIENTIFIC PERSONNEL AND SCHOLARSHIPS

The Administrator is to maintain a register of scientific and technical personnel and to provide in general a central clearing-house for information concerning such personnel.	The Foundation is to maintain a register of scientific and technical personnel and to provide in general a central clearing-house for information concerning such personnel.
The National Roster is to be transferred to the Foundation.	The National Roster is not specifically mentioned.
Fellowships and scholarships are provided for in any field of science in institutions of the candidates' own choosing in the United States and abroad.	Scholarships and graduate fellowships are provided for in all fields of science in institutions of the candidates' own choosing in the United States and abroad.

RESEARCH FINDINGS AND PATENT RIGHTS

A series of specific standards are provided which will govern the Administrator in the disposition of inventions and findings. (Identical with S. 1850.)	The Foundation is to have complete authority to dispose of inventions "in a manner calculated to protect the public interest and equities" of the contracting parties.

TECHNICAL PAPERS

Effect of Urethane on Mouse Myelogenous Leukemia[1]

Ruby M. Engstrom, Arthur Kirschbaum,
and Harry W. Mixer[2]

Departments of Anatomy and *Radiology,*
University of Minnesota Medical School

It has been reported that the administration of urethane to human leukemic patients produces an effect similar to that following treatment with X-rays (*2*). In preliminary experiments the authors have investigated the effects of urethane on normal and leukemic myeloid tissues of mice.

The leukemia used in this investigation was a transplanted myelogenous chloroleukemia in the fifth transfer generation. The disease developed was a chronic leukemia with the white blood-cell count always rising to more than 100,000 cells/mm.^{3} This transfer line was derived from a spontaneous leukemia which had arisen in an F_1 hybrid mouse between strains F (high leukemia) and NH (low leukemia), transfer has always been into mice of this hybrid genetic constitution. The disease developed in 76 of 77 mice inoculated, and there were no spontaneous recoveries. Six to eight weeks after inoculation, white blood-cell counts were decidedly elevated, and the spleen was palpable. Mice survived as long as four months following the intraperitoneal inoculation of leukemic cells suspended in isotonic saline. The blood picture was typical of myelogenous leukemia, with stem cells and all intermediate forms down to mature leucocytes. Anemia developed as the disease progressed to fatal termination.

Urethane[3] in aqueous solution was administered intraperitoneally, the daily dose ranging from 0.004 to 1.0 mg./gram of body weight. The dose per gram of mouse was contained in 0.01 cc. of distilled water. After three daily doses of either 0.5 or 1.0 mg./gram of body weight (the latter is an anesthetic dose), white blood-cell counts dropped from over 100,000 cells/mm.^{3} to normal levels, the only mononuclear cells of the circulating blood being lymphocytes. Spleen and lymph nodes were definitely reduced in size, although microscopic examination revealed that these organs, the lung, and liver contained leukemic cells. The cellular picture of the bone marrow was altered. In contrast to the decided left shift in white cell development characterizing the marrow of mice with myeloid leukemia, many mature leucocytes were now present. A similar alteration was noted after X-ray therapy (three to five daily doses of 80 r to the whole body), with the counts also dropping to normal levels. Reduction in size of spleen and lymph nodes was greater, however, following urethane treatment. The effect of urethane was similar in all of 13 mice treated with this dose. This transplanted leukemia failed to respond in a similar manner to either Fowler's solution, benzol, or colchicine.

Within three days after daily treatments with urethane in doses of either 0.5 or 1.0 mg./gram of body weight, leukemic mice lost as much as 7 grams (initial weight, 25–28 grams). When the daily dose of urethane was reduced to 0.2 mg./gram of body weight, leucocyte counts still dropped, but weight loss was not appreciable. Counts fell from 150,000–200,000 to 50,000 white blood cells within 7 days, but the lymph nodes and spleen were not decreased in size. This dose of urethane proved ineffective in maintaining the low leucocyte counts previously induced by larger doses. Although the white blood-cell counts rose, and spleen and lymph nodes increased in size, the percentage of mature leucocytes in the blood was greater than that seen in untreated animals. Larger doses of urethane again brought down the white counts and reduced the size of spleen and lymph nodes.

A single dose of 0.1 mg. of urethane/gram of body weight effected a significant dip in the white count in the first 24 hours, followed by a prompt rise to the initial level. There was no further response to the daily administration of this small dose. Doses of less than 0.1 mg. did not alter the white counts.

Experiments are being undertaken to determine whether life can be prolonged when leukemic mice of this transfer line are treated with urethane. In future experiments treatment will also be started earlier in the development of the transplanted disease. Mouse leukemia should provide favorable material with which to determine under controlled conditions the possible effect of urethane on survival time in the human disease.

Two cases of spontaneous mouse leukemia have also been treated with urethane. One, a lymphatic leukemia with a white blood-cell count of 63,000, failed to respond to daily injections of 0.2 mg./gram of body weight. The second, a myelogenous leukemia, responded in the same manner as the transplanted disease, exhibiting a depression in leucocyte count from 82,000 to 20,000 within a week, and decrease in size of the spleen.

It is of interest that in these experiments the response of mouse leukemia to urethane was comparable to that seen in human leukemia (*2*). Urethane has been shown to retard the growth of certain neoplasms of the mouse and human, although the alteration was not permanent (*1*). In the present experiments it was noted that if treatment with urethane was discontinued, the white blood-cell counts became elevated, and spleen and lymph nodes enlarged. In two instances, however, the counts remained depressed for almost two weeks after cessation of treatment. Two weeks is a relatively long time in the course of mouse leukemia.

Urethane induced a depression in the leucocyte count of nonleukemic human subjects (*2*). In normal mice doses of 0.5 or 1.0 mg./gram of body weight produced a similar effect, but neither the drop in leucocyte count nor loss of body weight

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[1] This investigation has been aided by grants from the Jane Coffin Childs Memorial Fund for Medical Research, the National Cancer Institute, and the Cancer Fund of the Graduate School of the University of Minnesota.

[2] National Cancer Institute Trainee in Radiology.

[3] Urethane Merck (ethyl urethane-ethyl carbamate).

appeared as rapidly as in leukemic mice similarly treated. Daily doses of 0.2 mg. or less/gram of body weight given for three weeks proved to be nontoxic for normal mice. Doses of urethane which affected leukemic marrows produced no striking cytologic alterations in the bone marrow of normal mice.

References

1. Haddow, A., and Saxton, W. A. *Nature, Lond.*, 1946, **157**, 500.
2. Paterson, E., Thomas, I. A., Haddow, A., and Watkinson, J. M. *Lancet*, 1946, **250**, 677.

The Role of Arsenic in the Production of Alcoholic Polyneuritis

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In view of the experimental work which led to the discovery of BAL (British anti-lewisite) it might be worth while to mention some unpublished results obtained on the urinary excretion of arsenic in patients suffering from alcoholic polyneuritis. The signs and symptoms of arsenic polyneuritis are so similar to those seen in alcoholic polyneuritis that it seemed possible that arsenic as well as alcohol with its concomitant avitaminosis played a role in the latter. Twenty-four patients on the wards and 5 from the Outpatient Department of the Boston City Hospital were studied for urinary arsenic excretion. Fourteen of these suffered from alcoholic polyneuritis, while 15 patients were utilized as a control group.

Six of the 14 patients had paralysis and loss of sensation of all four extremities; 5 had a moderate, and 3 a mild, type of polyneuritis. (The additional diagnosis of Korsakoff's psychosis was made in 5, delirium tremens in 1, and signs of pellagra were present in 2.)

The 15 patients utilized as a control group fell into four groups: (1) those suffering from acute infective polyneuritis; (2) patients suffering from chronic alcoholism without signs of neuritis; (3) a group chosen at random on the ward; and (4) some outpatients who had had alcoholic polyneuritis in the past but who denied the use of alcohol at the time tested.

An attempt was made to collect at least three 24-hour urine specimens from the 24 hospitalized patients. Several had more than 3 specimens tested; the maximum was 11. Only one or more single specimens were collected from the 5 outpatients. The Reinsch test was used on all specimens, and those from 2 patients containing the largest amounts of arsenic were checked by the Gutzeit quantitative test. One patient was excreting as much as .227 mg. of arsenic/1,000 cc. of urine.

The more severe the paralysis, the more positive were these tests for arsenic. Arsenic is not a normal constituent of the body but is present due to ingestion with food. It is possible that alcohol affects the storage of arsenic, which in turn contributes to the interference with enzyme action already present in these malnourished patients.

The 14 patients suffering from alcoholic polyneuritis were consistently excreting significant amounts of arsenic in the urine, while the 15 in the control group showed only an occasional trace of this element.

Mass Mortality of Marine Animals on the Lower West Coast of Florida, November 1946–January 1947

Gordon Gunter, F. G. Walton Smith, and
Robert H. Williams[1]

Marine Laboratory, University of Miami,
Coral Gables, Florida

Catastrophic mass death involving millions of fish recently occurred on the south Florida Gulf Coast. In the latter part of November 1946, mackerel fishermen noted dead and dying fish and turtles in streaks of discolored water 10–14 miles offshore from Naples. The mortality moved northward and reached Boca Grande by January 10. Fish continued dying in the bays behind Captiva and Sanibel Islands as late as January 29. Investigations carried out since January 15 have resulted in the following observations.

Dead fish, in association with discolored water, were reported from Dry Tortugas to Boca Grande, a distance of 130 miles. At Fort Myers on January 19 the beach was littered with fish in excess of 170/foot of shore line, in addition to those floating on the water in bays and sounds and to a distance of 10 miles offshore. One homeowner on Captiva Island reported burying 60,000 fish from 200 feet of bay beach. The same area had to be cleaned on three other occasions. The total number of dead fish over the whole area was estimated to be over 50,000,000. Oysters, clams, crabs, shrimp, barnacles, and coquinas were also killed. The clam industry at Marco, 50 miles south of Fort Myers, and the sponge industry north of Tampa Bay do not appear to have been involved, nor, in spite of an isolated report of dead fish from a vessel passing Dry Tortugas, does the mortality appear to have reached the Florida Keys. All kinds of fish succumbed. Mackerel seemed to be relatively unaffected, but many mullet were killed. Floating carcasses of black drum, tarpon, groupers, and large jewfish were the most spectacular sights.

Reports of the phenomenon were not received by the writers until the middle of January. From January 18 onward, the water was sampled chemically and with plankton nets near Sanibel Island, where dying fish were encountered; at Fort Myers Beach, where dead fish only were found; and at Naples, where the water was beginning to clear up and the fishermen were making mackerel catches.

Reddish-brown discoloration of the water was observed off Fort Myers Beach. Plankton examination showed this to be unusually rich, consisting predominantly of copepods and invertebrate larvae with little phytoplankton. At Clam Bay dying fish were seen in streaks of greenish-yellow water. These streaks contained large quantities of diatoms with *Coscinodiscus* sp. as the dominant organism, together with considerable detritus and smaller numbers of naked flagellates resembling species of *Gymnodinium*. The water at Naples, which was not discolored, contained copepods and a great abundance of *Rhizosolenia* sp. No one species was overwhelmingly predominant at all stations, but the organisms tentatively identified as *Gymnodinium* sp. were found in varying numbers in samples from the areas where fish were still dying.

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[1] The writers are much indebted to J. N. Darling, of Captiva, Florida, for information and assistance given during the course of this investigation.

A patch of vivid yellow water, seen south of Useppa Island on January 28, consisted almost exclusively of *Gymnodinium* sp. with a mixture of numerous larval invertebrates. The water was viscid and slimy, having the consistency of diluted syrup. A fish was seen dying in this water.

Chemical determinations disclosed no unusual salinities. Water temperatures ranged from 22.5° C. to 26° C. Samples showed a pH close to 8.2. The dissolved oxygen content was not low in brownish-red water near Fort Myers Beach except in an inshore area where large numbers of dead fish littered the water. In the yellow patch of water described above the oxygen content was low, being less than 33 per cent saturated. Hydrogen sulfide was reported earlier at Naples, and the hulls of several fishing vessels were seen with the white topside paint definitely blackened. During the period of investigation no H_2S could be detected.

An odorless but acrid gas causing stinging of the nostrils and hard coughing made life miserable for the residents of Captiva Island when a northwest wind caused a heavy surf on the Gulf Beach from January 22 to 26. This gas, which could not be identified, was not present during calm weather on January 28, but could be detected by boiling samples of Gulf and bay water. It was particularly strong in a sample of the yellow water. Lund (*1*) has previously called attention to presence of this gas during a similar heavy mortality of fishes on the Texas Coast.

A report giving full details of observations on this phenomenon will be published later.

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The Glyceride Structure of Natural Fats

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Naturally occurring fats and oils consist predominantly of esters of glycerol and fatty acids, each hydroxyl group of the glycerol being esterified with a mole of fatty acid. A number of different fatty acids (usually at least four) make up any given fat. Because of the number of fatty acids and the fact that there are three positions on each glycerol molecule to which the fatty acids may be attached, a large number of isomeric glycerides is possible in a single natural fat. Thus, if n represents the number of component acids, the theoretical number of isomers possible from a maximum distribution of the acids over the three positions of glycerol is n^3. The actual number of glycerides chemically distinguishable from one another is $\frac{1}{2}(n^3 + n^2)$ (*4*).

In general, the glycerides of natural fats are highly mixed, simple triglycerides being the exception rather than the rule and occurring for the most part only in the relatively few fats in which a single fatty acid predominates. Since natural fats consist largely of isomeric glycerides, many of which differ from each other only slightly with respect to physical and chemical properties, the analysis of fats for their component glycerides has been an extremely difficult problem. For many years various investigators, especially Prof. Hilditch and his co-workers, have attempted to enlarge upon our rather meager knowledge of the glyceride structure of natural fats. The chief result of the investigations at the University of Liverpool has been the pronouncement of the so-called "rule of even distribution" (*3*). According to this hypothesis, the individual fatty acids of a fat tend to be apportioned evenly among the different glyceride molecules. In seed fats, for example, it is pointed out that trisaturated glycerides do not usually appear until the proportion of fatty acids reaches approximately 60 per cent. Numerous exceptions to this rule have been discussed by Hilditch, and a rough classification of fats has been made on the basis of their conformity to this rule.

An analysis of the "rule of even distribution," however, reveals the fact that truly "even" distribution is not proposed. Rather, it is maintained that, at fatty acid molar concentrations of approximately 60 per cent, homogeneous triglycerides of that fatty acid first appear—something less than "even" distribution. Frequently an association ratio (molar ratio of saturated to unsaturated fatty acids) of 1.4:1.0 is used, which is equivalent to a 58 per cent molar concentration of saturated fatty acids. On the basis of a truly "even" distribution, however, no homogeneous triglyceride should be formed until the molar concentration of the fatty acid in question is 66.7 per cent—that is, until more than two-thirds of the fatty acid molecules are the same. This is illustrated in Fig. 1, in which 10 glyceride molecules are shown graphically. It is apparent that 20 saturated fatty acid radicals could be attached to the glycerol molecules without any glyceride containing more than two saturated fatty acids. The 21st saturated fatty acid, however, must unite with a glyceride already containing two molecules of the same fatty acid, consequently producing a molecule of trisaturated glyceride. An extension of this reasoning to a greater number of glycerol molecules leads to the obvious conclusion that only when the molar concentration of the saturated fatty acids exceeds two-thirds would saturated triglycerides be formed under a truly "even" distribution. Thus, the molar concentration of trisaturated glycerides, $[S_3]$, can be related to the molar concentration of saturated fatty acids, $[S]$, as follows:

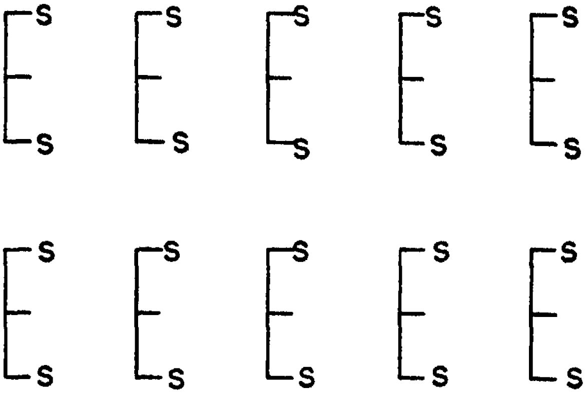

Fig. 1

$$[S_3] = 3\,([S] - 66.7).$$

In general terms, if S_3 represents the triglycerides of any fatty acid, S, then the above equation defines "even" distribution as the term is employed in this paper.

Prof. Hilditch (*5*) has noted that fruit coat fats do not adhere well to the "even distribution hypothesis" and that land animal fats in general constitute notable exceptions. He has further pointed out that the glyceride structure of natural animal fats corresponds to that of synthetic mixed glycerides, in which the relationship of trisaturated glycerides, $[S_3]$, to mole per cent saturated acids, $[S]$, is expressed by the equation

$$[S_3] = k[S]^3,$$

where S_3 and S have the same significance as in the previous equation and k is a proportionality constant. Thus, the mole per cent of trisaturated glycerides is proportional to the cube of the mole per cent of saturated fatty acids. It should be noted that this equation is a specific example of the general equation $Y = k\ (X)^3$, which expresses the probability of any given arrangement of three independent variables. This, of course, is quite different from "even" distribution and, as will be shown later, really describes so-called "random" distribution.

In the chemical synthesis of glycerides from mixed fatty acids and glycerol, the amounts of the various glycerides formed would be expected to depend upon random collision and reaction, which is amenable to mathematical treatment on the basis of the laws of probability. Thus, the probability of oleic, palmitic, and stearic acids (equal reactivity assumed for each) uniting with glycerol depends upon their respective concentration; that is, the probability of oleo-palmito-stearin being formed is expressed by the equation:

$$[(OPS)] = k\ [O]\ [P]\ [S].$$

Increasing the concentration of any one of these acids increases the probability of that triglyceride being formed. It follows that if all the saturated acids were lumped together as S, the equation for the per cent of trisaturated glycerides would be:

$$[(SSS)] = k\ [S]\ [S]\ [S] = k\ [S]^3.$$

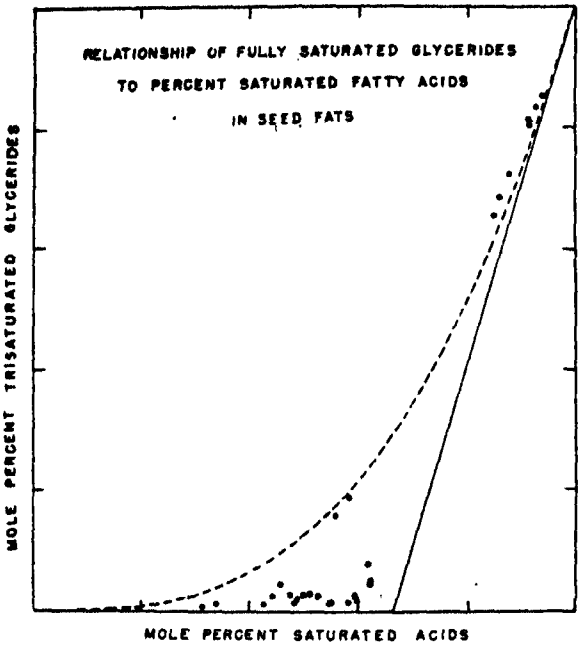

FIG. 2

Experimentally, the only component of a glyceride mixture which can be determined with relative ease and accuracy is the trisaturated glyceride fraction. In the past it has been tacitly assumed that the total glyceride structure may be deduced if the relationship between saturated fatty acids and trisaturated glycerides is known. As a result, this relationship has been rather extensively investigated (*3*). In Figs. 2, 3, and 4 representative data from the literature are compared with curves representing the above equations for "even" and "random" distribution.

From Fig. 2 it is apparent that the experimental data for seed fats do not coincide well with either the straight line representing "even" distribution or with the curve representing "random" distribution. However, it must be noted that, according to Hilditch's hypothesis, the intercept of the straight line with the axis would be at approximately 58 mole per cent saturated acid rather than at 66.7 per cent, which represents truly "even" distribution. This transposition of the curve to the 58 per cent intercept would, of course, result in a better agreement of some of the points with the so-called "even distribution hypothesis." It should also be noted that the points in the upper part of the curve fit either "even" or "random" distribution about equally well. To illustrate this point, in Table 1 we have compared the amount of trisaturated glycerides anticipated on the bases of "even" and of "random" distribution in fats containing large amounts of saturated fatty acids. It is evident that, at high saturated fatty acid concentrations, calculations based upon the two theories give so nearly identical results that data obtained for fats in this range (85 per cent or more saturated acids) cannot be interpreted as favoring either hypothesis.

TABLE 1

MOLAR CONCENTRATIONS OF TRISATURATED GLYCERIDES CALCULATED FOR FATS CONTAINING HIGH MOLAR CONCENTRATIONS OF SATURATED ACIDS

Molar concentration of saturated acids	Molar concentration of trisaturated glyceride	
	Calculated for "even" distribution	Calculated for "random" distribution
94	81.9	83.0
93	78.9	80 3
92	75.9	77.8
91	72.9	75.3
90	69.9	72.9
85	54.9	61.3

In Fig. 3 the molar concentration of saturated acids versus that of trisaturated glycerides is plotted for fruit coat fats. In this case it is seen that the data definitely do not agree with those expected on the basis of either hypothesis.

Similar data for animal fats, as shown in Fig. 4, reveal that the molar concentrations of trisaturated glycerides in animal fats closely approximate the values anticipated from the equation $[Y] = k\ [X]^3$. From this observation it may be generalized that the over-all glyceride structures of animal fats probably approximate those which would be anticipated from a "random" distribution of the fatty acids over the available glycerol molecules. The same generalization has been proposed by Dean, who used the terms "indiscriminate" and "haphazard" to define the distribution of fatty acids in animal fats and synthetic glycerides (*2*). The term "random distribution" was later used by Longenecker (5), who elaborated the general equation $[Y] = k[X]^3$ to include specific glycerides of all possible configurations. Similar equations have recently been published by Bailey (1).

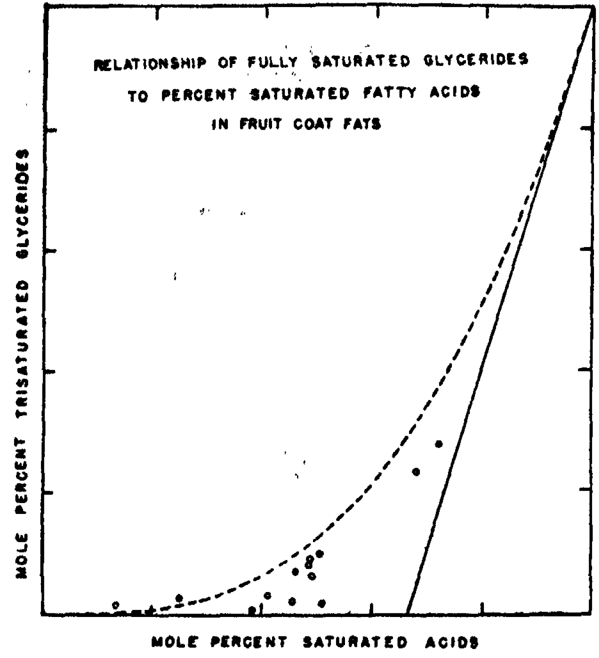

FIG. 3

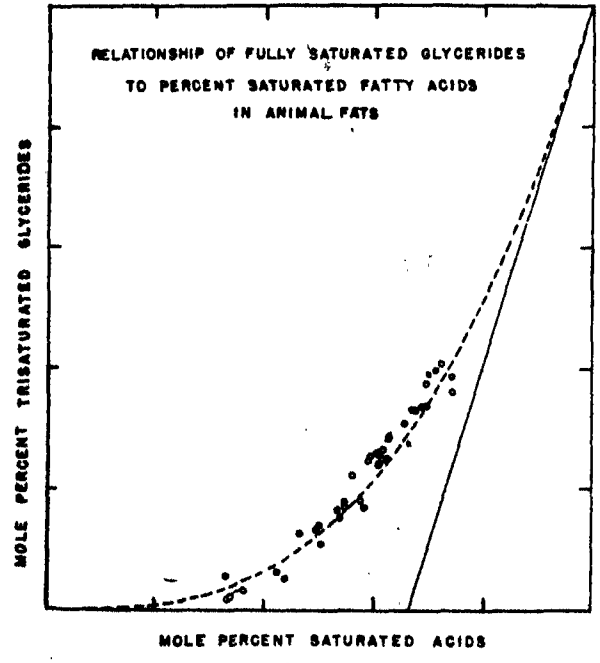

FIG. 4

In summary, an analysis of representative data showing the relationship of the molar concentrations of trisaturated glycerides to those of saturated acids in natural fats reveals that in the case of animal fats the glycerides are formed by a "random" or nearly "random" distribution of fatty acid radicals among the glycerol molecules. It has been shown that the "even distribution hypothesis" does not represent truly "even" distribution, but rather is an approach to the latter, being more or less arbitrarily fitted to experimental data. No general class of fats adheres to truly "even" distribution. Seed fats appear to approach the trisaturated glyceride contents anticipated by the "even distribution hypothesis," but even here the data are inconclusive.

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Effect of Vitamin B Complex on Inactivation of Estrone *in Vivo* and *in Vitro*

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In 1934 Zondek (6) found that estrone is inactivated by animals and plants. In experiments carried out *in vivo*, rats were injected with estrone and killed a few hours later. The bodies were finely minced, extracted, and the extract assayed as to estrogenic activity. Only about 2–4 per cent of the estrogenic activity of the injected estrone solution was recovered. Subsequent hydrolysis improved the recovery to 6–20 per cent. The major part of the inactivation was therefore not due to esterification. In numerous experiments inactivation of estrone by rats *in vivo* was consistently observed. Over a period of many years we have not chanced upon a single case in which such inactivation failed to occur.

In experiments carried out *in vitro*, pulps of various organs were incubated for some hours with estrone at 37°C., the mixture then being tested for estrogen activity. It was found that liver brei inactivates estrone to an extent of about 90 per cent, while of other organs tested only spleen inactivates estrone to a small degree. Hydrolysis of the inactive mixture does not liberate any estrogenic activity. It should be mentioned that not all livers tested inactivate estrone: for some unexplained reason, liver brei of normal rats occasionally fails to mediate this reaction.

Since heating inactivates liver pulp estrone, it may be concluded that the inactivation is enzymatic. This enzyme, which has been designated by one of us (B. Z.) as estrinase, has been obtained in cell-free extracts of liver and of various plants (6, 7). The plant enzyme is closely associated with tyrosinase and inactivates estrone presumably by oxidation (5).

Recently Biskind and Biskind (1) have pointed to the existence of a relationship between the amount of vitamin B com-

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[1] Aided by a grant from the Rockefeller Foundation.

plex in liver and the ability to inactivate estrone. These authors implanted pellets of estrone into spleens of adult castrated female rats. On a normal diet the animals remained anestrous. When the rats were given a vitamin B-complex-free diet, vaginal estrus occurred. In another series of experiments Biskind and Shelesnyak (*2*) castrated female rats and transplanted one ovary into the spleen. On a normal diet they remained anestrous, but when kept on vitamin B-complex-free diet, estrus appeared.

TABLE 1

INACTIVATION OF ESTRONE BY VITAMIN B-COMPLEX-DEFICIENT RATS *in Vivo*

Rat No.	Duration of vitamin B-complex-free diet (days)	Wt. of animal (grams)		Time elapsed between injection of estrone and killing of rat (hrs.)	Amount of estrone injected (I.U.)	Recovery of estrone (%)
		Start	Final			
1	33	25	23	5	2,000	0–10
2	30	25	20	5	1,600	10
3	30	25	25	5	2,000	10
4	30	40	32	4	1,000	10
5	30	45	36	4	1,000	10
6	30	42	35	4	1,000	25
7	30	40	27	4	1,000	0–10
8	30	40	29	4	1,000	0–10
9	32	47	35	2	2,000	25
10	32	47	37	2	2,000	50

Shipley and György (*3*) observed an impairment of ability to inactivate estrone *in vivo* in rats maintained on diets low in protein and high in fat. Vitamin B-complex deficiency induced similar but less constant response. Not all strains of rats tested by these authors reacted to the vitamin B-complex deficiency with less ability to inactivate estrone.

Singher, *et al.* (*4*) examined the dependence of inactivation of estrogens on vitamin B-complex deficiency and have shown that liver slices of riboflavin- and thiamine-deficient rats are unable to inactivate estradiol.

In experiments carried out on 28 vitamin B-complex-deficient female rats we have found that vitamin B deficiency has no influence on the inactivation of estrone by rats *in vivo*. Table 1 summarizes the results obtained with 10 rats kept for one month on a vitamin B-complex-free diet.[2] Most of the animals were near death after three weeks of the experiment, and a few died from cachexia caused by vitamin B-complex deficiency before the inactivation test could be performed. In the inactivation experiments, vitamin B-complex-deficient rats were injected with 1,000–2,000 I.U. of estrone.[3] These were killed 2–5 hours following the injection, and the minced bodies were analyzed as to their estrogenic content by the Allen-Doisy method. The inactivation after 2 hours was of the order of 50–70 per cent; after 4–5 hours, 75–100 per cent.

On the other hand, liver pulps of avitaminotic rats, contrary to normal liver, in a majority of cases uniformly fail to inactivate estrone. Table 2 shows results obtained with liver brei of 7 vitamin B-complex-deficient rats incubated with 250–500 I.U. of estrone in phosphate buffer pH 7.3 at 37°C. for 3–5 hours. The recovery of estrone was quantitative, and only in one case was there a measurable loss (25 per cent) of original estrogenic activity.

Hence, (1) the vitamin B-complex-deficient rats are able to inactivate estrone *in vivo* as are normal rats; (2) whereas the liver of normal rats inactivates estrone *in vitro* in a high percentage of cases, liver of vitamin B-complex-deficient rats does not inactivate estrone *in vitro*.

TABLE 2

INACTIVATION OF ESTRONE BY LIVER BREI OF VITAMIN B-COMPLEX-DEFICIENT RATS

Rat No.	Duration of vitamin B-complex-free diet (days)	Wt. of animals (grams)		Wt. of liver (grams)	Time of incubation with estrone at 37°C. (hrs.)	Amount of estrone used (I.U.)	Recovery of estrone (%)
		Start	Final				
11	25		40	1,600	5	500	100
12	22	40	30	1,700	4	500	100
13	22	40	32	1,650	4	500	100
14	35	45	40	1,800	4	500	100
15	28	45	36	1,550	3	500	75
16	28	48	37	1,700	3	500	100
17	23	45	24	1,800	3	250	100

The question as to whether the inability of liver of vitamin B-deficient rats to inactivate estrone *in vitro* is due to vitamin B-complex deficiency is under investigation.

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[2] We are obliged to Dr. M. L. Tainter, Winthrop Chemical Company, Rensselaer, New York, for supplying us with this material.

[3] We are indebted to Dr. B. J. Brent, Roche Organon, Inc., who supplied estrone.

Feeding of Oysters in Relation to Density of Microorganisms

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Regardless of extensive studies on the physiology of oysters (*Ostrea virginica*), many problems concerned with their food and feeding are still unsolved and several are vigorously debated. For example, biologists do not agree on the effects of different quantities of material suspended in water upon the efficiency of the feeding of oysters. One group of workers, headed by Kellogg (*2*), maintains that oysters and other lamellibranchs are able to feed only when the water is comparatively clear, while another, represented by Grave (*1*), states that they can feed even in very turbid water. To clarify at least certain aspects of this problem we have made a study of the effect of different concentrations of microorganisms upon the rate of water pumping and, therefore, feeding of oysters.

Experiments in which oysters were fed *Chlorella* sp., *Nitzschia closterium*, *Euglena viridis*, other plankton forms, and a common variety of yeast have shown that there are rather definite concentrations above which the density of the microorganisms begins to interfere with the feeding of oysters. These concentrations corresponded to approximately 2,000,000 *Chlorella*, 70,000 *Nitzschia*, and 3,000 *Euglena*/cc. of water. As may be seen, the size of the cells played an important part because a much higher number of small cells, such as *Chlorella*, was needed to produce the same effect as that caused by a smaller number of larger organisms.

In concentrations higher than those given above, the rate of feeding was reduced, and the character of the shell movement of the oysters changed noticeably. In many experiments a correlation was noticed between the density of the microorganisms and the rate of feeding. When the plankton cells were too abundant, little or no food was swallowed by the oysters and the crystalline style was usually absent. Under such conditions the oysters ejected large quantities of pseudofeces to cleanse their gills and palps of an excessive accumulation of plankton. Sometimes the shells remained open for periods of several hours, although no water was pumped. If the oysters were kept in heavy concentrations for a long time, they became sluggish, their responses to stimuli diminished, and the tonus of the adductor muscle was partially lost.

Both the filtrate of the cultures, containing metabolic products of the cells, and the cells themselves affected the oysters because the rate of feeding was reduced or even entirely stopped when they were subjected to strong concentrations of either component.

When, after exposure to heavy concentrations of microorganisms, the oysters were again subjected to a flow of sea water, their rate of feeding usually showed a marked increase. The intensive pumping of water indicated an attempt to remove the microrganisms which had accumulated in the gills and mantle chamber.

In light concentrations, which contained fewer cells than those mentioned above, the rate of feeding and the shell movements remained normal. In many instances the rate of feeding was even greater than when the oysters were kept in running sea water. The possibility is not excluded that the presence of small quantities of plankton in sea water stimulates the pumping activities of the oysters.

The quantities of pseudofeces formed by the oysters were usually roughly proportional to the quantities of plankton present in the water, whereas a reverse relationship existed in the formation of true feces. The presence of large quantities of pseudofeces usually indicated that feeding proceeded under the relatively unfavorable conditions caused by heavy concentrations of plankton in the water. Small quantities of pseudofeces, or their absence, in the presence of large quantities of true feces showed that the oysters were feeding efficiently.

The results of our experiments indicate that both Kellogg and Grave were only partially correct in their conclusions. The opinion advanced by Kellogg, that oysters feed most efficiently only if the water contains small quantities of suspended matter, was corroborated by our studies. Contrary to his opinion, nevertheless, we found that oysters can also feed in water containing a relatively large number of microorganisms, although under such a condition the rate of feeding is decreased. It is true, however, that when the plankton is too heavy, the oysters cease feeding. On the other hand, Grave's conclusion may be considered correct only if it was qualified with the statement that the efficiency of feeding of oysters decreases in water rich in microorganisms. Since no such statement was made by Grave, his conclusion creates the impression that it is unimportant whether or not the water is relatively clear or heavily laden.

A full description of these studies will appear in the official publication of the U. S. Fish and Wildlife Service.

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Antagonistic Effect of *Corynebacterium diphtheriae gravis*

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The object of this note is to report the occurrence of an antibiotic effect produced by *Corynebacterium diphtheriae gravis* against several organisms. This strain of *C. diphtheriae gravis* was isolated in a culture from a diphtheritic throat and was identical in all particulars to the requirements of this organism. It was the specimen used in instruction of medical bacteriology at the Naval Medical School.

In checking its characteristics on potassium tellurite blood agar, the plate containing 15 mg. potassium tellurite/100 ml. blood agar became contaminated with *Bacillus subtilis*. The result is shown in Fig. 1. The black, clearly defined colonies are *C. diphtheriae*; the confluent growth, *B. subtilis*. About many of the *C. diphtheriae* colonies is a clearly defined zone where growth of *B. subtilis* has been inhibited.

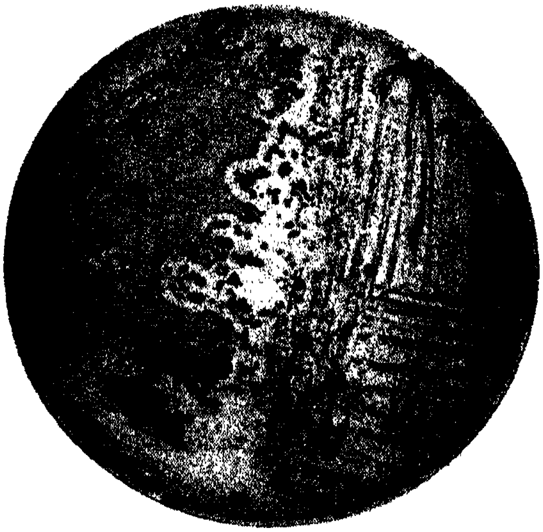

Fig. 1

Using moist blood agar plates containing the same amount of potassium tellurite, the strain of *C. diphtheriae gravis* was tested against *Proteus vulgaris*, *Salmonella typhimurium*, and *S. paratyphi A*. The same inhibitory effect was observed.

In October 1945 one of us was discharged from the Navy and this investigation ceased, although cultures of the organism were carried for future work. Eight months later an attempt was made to repeat and amplify the above experiments. During the extended period of storage and irregular transfer, however. the organism had apparently lost its ability to produce the inhibitory effect, and no antagonistic activity was demonstrable. Prior to loss of this effect no attempt was made to separate the diphtheritic exotoxin from the possible antibiotic substance.

Since there is no previous record of antagonistic activity of *C. diphtheriae*, this note is presented merely to record the fact that *C. diphtheriae gravis* may produce an antibiotic substance and to stimulate others to look for it among strains of this genus.

Mechanism of Sex Determination

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It has long been known that the ratio of males to females, 106:100 (*7*) in man, deviates appreciably from the 100:100 ratio which is predicted on the basis of the chromosome theory. This deviation has also been observed in plants and in other animals. Correns (*3*) thought that in plants, among other influences, might be the different masses of the male- and female-producing pollen grains. Bluhm (*2*), in her work with white mice, suggested the different masses of the two types of sperm as a factor, stating that male-producing sperms (androsperms) may have a better chance to reach the egg than the gynosperms because of their lesser mass of chromosome. Zeleny and Faust (*6*) found dimorphism in the sperm cells of 15 animal species. They believe that the two types of sperm are androsperms and gynosperms and that, due to their different masses, they may have different chances to reach the egg. Parkes (*5*) found dimorphism in the case of man, the rat, and the mouse.

This explanation involves the assumption that the average kinetic energy of both types of cell is the same, so that the two types travel with different velocities due to their differences in mass.

The purpose of this paper is to show that, to produce an appreciable difference between the velocities of the two types of cells, the differences in mass would have to be larger than could reasonably be expected.

By the definition of kinetic energy,

$$KE_x = \tfrac{1}{2}m_x v_x^2 \quad \text{and} \quad KE_y = \tfrac{1}{2}m_y v_y^2,$$

where KE_x is the average kinetic energy of a gynosperm; KE_y, that of an androsperm; m_x, the average mass of a gynosperm; and v_x, the average velocity of a gynosperm.

If the average kinetic energy of androsperms and gynosperms is equal,

$$\tfrac{1}{2}m_x v_x^2 = \tfrac{1}{2}m_y v_y^2 .$$

Hence,

$$\frac{m_x}{m_y} = \left(\frac{v_y}{v_x}\right)^2 .$$

Thus, the ratio of the masses of gynosperms to androsperms must be equal to the inverse ratio of the velocities of the two types of cells, squared. However, the number of males born must be proportional to v_y, and the number of females to v_x; hence, for a ratio of, for example, 106 males:100 females, we have:

$$\frac{v_y}{v_x} = \frac{106}{100} = 1.06. \quad \text{Since} \left(\frac{v_y}{v_x}\right)^2 = 1.1236, \quad \frac{m_x}{m_y} = 1.1236.$$

This means that, to account for a ratio of 106:100, an average difference of about 12 per cent would have to exist between the masses of androsperms and gynosperms. If one takes into consideration the high index of mortality of male zygotes, the primary ratio of males to females must be at least 116:100 (*1*). Using this ratio in the above calculation, one obtains: $\frac{m_x}{m_y} = 1.3456$, which would be a difference of about 35 per cent in the average masses of androsperms and gynosperms.

The difference is mass is presumably due to that of only one chromosome (*4*). It then becomes apparent that the difference in mass between androsperms and gynosperms would have to be far greater than cytological evidence permits us to deduce in order to explain this great deviation from the normally expected 100:100 ratio, if mass of chromosome alone were to be considered the decisive factor.

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IN THE LABORATORY

Effects of X-Radiation on Thymus Nucleic Acid

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and Alexander Hollaender
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Since the work of Muller in 1927, X-rays have become a tool in the production of chromosomal aberrations and artificial mutations in plant and animal cells. Although the effects of X-radiation have been investigated with regard to the organism as a whole and to its cellular and nuclear constituents, no clearly defined mechanism of action has emerged. The occurrence of nucleic acid, especially the desoxyribose type, in the chromosomes of all known cells warrants an investigation of the effects of X-rays on this substance.

Hollaender, Greenstein, and Jenrette (*3*) have shown that ultraviolet radiation produces a marked decrease in the structural viscosity and streaming birefringence of aqueous solutions of sodium thymus nucleate (TNA). Similarly, Sparrow (*4*) has demonstrated a fall in the viscosity of TNA upon X-radiation, the degree of change varying with the total dosage given. Since Sparrow's viscosity data were obtained at unknown velocity gradients, no conclusions can be reached regarding the structural viscosity of his solutions. In order to follow changes in structural viscosity it is necessary to measure the relative viscosity of the solution over a range of applied external pressures. When this is done, it is found that a marked decrease in structural viscosity occurs in TNA solutions irradiated with X-rays, similar to the change induced with ultraviolet radiation (see *2*), indicating an apparent decrease in the asymmetry of the nucleic acid particle with either type of irradiation.

Early in these studies it was noted that relative viscosity measurements at various pressures, made immediately at the end of the X-radiation period, cannot be compared because of the gradual decrease in the viscosity of TNA which occurs. This decay continues over a period of 18–24 hours, after which time the rate of fall in viscosity of the X-rayed sample approaches that of the control. Only then can comparative pressure studies be carried out. This continuous drop in viscosity subsequent to the cessation of X-radiation is shown in Fig. 1. The readings of relative viscosity taken 30 minutes after irradiation, allowing time for temperature equilibration, were: control, 22.9; 5-minute X-ray (28,000 r), 10.4; 10-minute X-ray (56,000 r), 7.3. The per cent of this first viscosity measurement is then plotted as a function of the time after irradiation.

Experiments were carried out on a dialysed solution of 0.7 per cent sodium thymus nucleate, prepared by the Hammarsten method from calf thymus. Viscosity was measured, relative to distilled water, in Bingham-Jackson viscometers at known pressures and at 30°C. X-ray dosage was delivered at the rate of 5,600 r-units/minute.

The rate of fall of the relative viscosity of TNA after the initial drop is markedly dependent upon temperature. If measurements of viscosity are carried out at 0°, the subsequent drop in viscosity with time is inhibited; both control and irradiated samples retain their viscosity as first measured. When brought up to 30°, after 5 hours at 0°, however, the per cent drop in viscosity of the X-rayed sample is consistently greater than that of the control. Thus, at least two phenomena are observed: (1) the primary effect of X-rays to decrease the viscosity of TNA, which is proportional to the dosage, acts during the exposure to X-rays and is independent of the temperature; and (2) a secondary, progressive, presumably indirect effect is manifested only at the higher temperature of 30° and cannot be detected at 0°C.

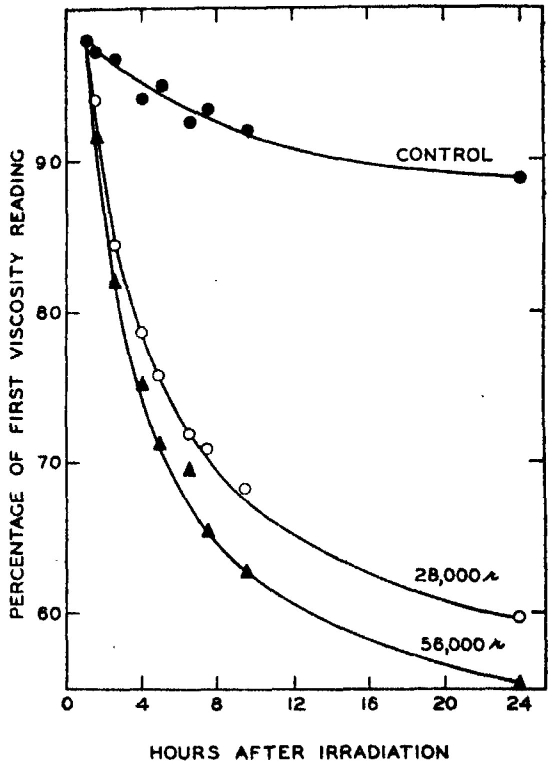

FIG. 1. Rate of decrease in viscosity of solutions of sodium thymus nucleate in terms of per cent of first reading at end of X-radiation period. Dialysed nucleate concentration was 0.7 per cent; temperature, 30°C.; external pressure, 18.4 cm. water.

It appears improbable that peroxide formed as a product of the X-radiation of water is concerned to any significant extent with the phenomena observed. Water was irradiated at 5,600 r/minute for 20 minutes and then added to a concentrated solution of nucleic acid. The drop in viscosity on standing was no different from that of a control diluted with the same amount of untreated water. The addition of H_2O_2 to a solution of TNA in concentrations of 10^{-3} and 10^{-6}M caused neither an initial nor a continuous drop in viscosity. It appears likely that the secondary decay in the viscosity of the TNA is the result of progressive intramolecular alterations in the nucleic acid particle, which are set in motion by the primary effect of the X-radiation.

In order to ascertain the nature of the change brought about by X-radiation of TNA, a series of chemical and enzymatic studies were undertaken. These results indicate that there is no splitting off of ammonia or inorganic phosphate upon irradiation; neither are any titratable acid groups opened up. Spectroscopic studies on the dialysates of control and X-rayed samples, according to the technique described by Carter and Greenstein (*1*), show that there has been no splitting off of purine- or pyrimidine-containing fragments small enough to penetrate a cellophane membrane. Presumably this indicates that if depolymerization has occurred, the molecular weight of the product molecules is still greater than 10,000. The ultraviolet absorption spectra of the control and X-rayed nucleates are identical.

Purified desoxyribonuclease (McCarty's preparation) and rat tissue extracts behave in an exactly parallel fashion toward control and X-rayed TNA. The specificity of the substance, as determined by its susceptibility to enzyme action, is in no way altered by the irradiation. Whatever the way in which the particle has been changed by X-radiation (whether by depolymerization or rearrangement involving a change in shape), the change in the axial ratio of the particle has not involved a splitting of primary linkages or a rearrangement of the spatial configurations necessary for its susceptibility to enzymatic attack.

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An Improved Oxygen Absorption Bulb for the Carpenter-Haldane Gas Analysis Apparatus

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One of the most time-consuming aspects of basal metabolism determination by the open-circuit method of Lewis (*2*) is the Carpenter-Haldane process (*1*) of gas analysis. Though this method yields excellent results, it is most tedious and laborious, particularly the process of oxygen absorption by an alkaline pyrogallol solution. To insure complete absorption of oxygen, the analyst must pass the gas sample into the pyrogallol tube about 25 times while he watches a weird little windshield wiper "burp" a rubber bulb to facilitate automatic circulation of the pyrogallol solution from the reservoir.

Numerous efforts toward a more rapid absorption procedure proved that the old Hempel tube method was highly applicable. The Carpenter oxygen absorption tube was replaced by a simple bulb with a capillary stem arranged so that it could be easily shaken by hand, and the original 800-cc. pyrogallol reservoir was replaced by a small 200-cc. bulb fitted with a water seal. The windshield wiper circulator was found unnecessary when the small volume of solution was more frequently renewed.

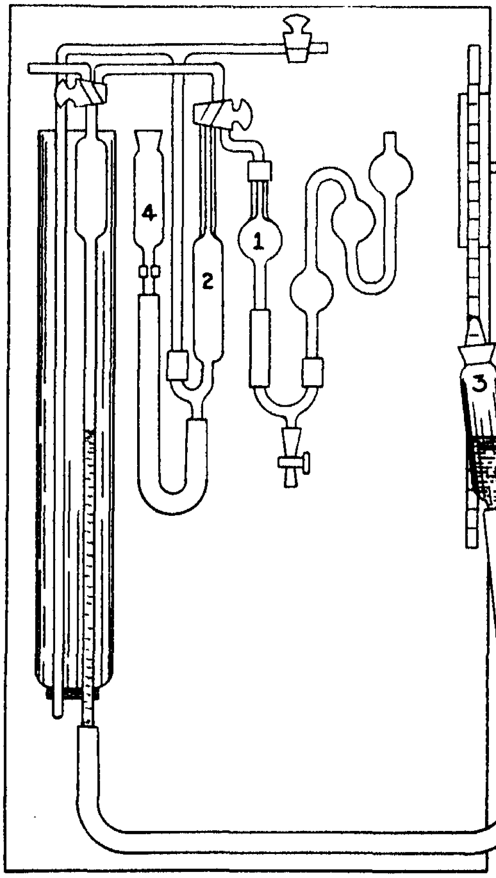

FIG. 1. Oxygen absorption bulb (1), KOH tube for CO_2 absorption (2), mercury leveling reservoir (3), and KOH reservoir (4).

Using this modified Hempel tube, the analysis of a gas sample is much the same as that by the Carpenter method. After CO_2 absorption in KOH solution, the gas sample is passed into the "Hempel" tube. The stopcock to this tube is closed, and the tube is shaken for about 10 seconds. This procedure is repeated 6 times, a burette reading being taken on the 5th and a check reading on the 6th. Thus, oxygen is completely absorbed after a total of 6 contacts with the pyrogallol solution.

With this improvement, the time necessary for a complete analysis of oxygen and carbon dioxide was reduced from the previous average of 30 minutes to about 15 minutes, a time decrease which looms more significant as the number of analyses increases.

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[1] The authors gratefully acknowledge the technical assistance of Milton Folawn.

A Mercury Switch for Thermocouples

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During the recent national emergency, when materials for research either were not available or were difficult to obtain within a reasonable period of time, the need arose for a switch which would automatically and alternately close each of two thermocouple circuits connected to a single recording potentiometer. Such a switch must be so constructed that the contact points do not become fouled, thus creating electrical resistance. To meet this need, the mercury switch described below was constructed and found to operate efficiently.

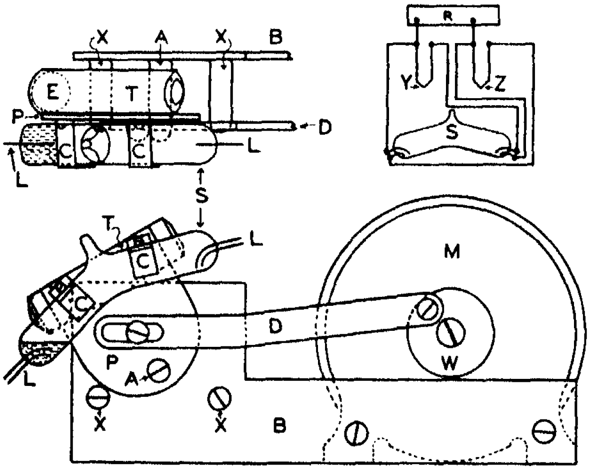

FIG. 1

The switch proper (S) was made from a piece of 12-mm. soda-lime glass tubing, 65 mm. in length and bent to form an angle of about 150°, as shown in the front and top views in Fig. 1. Two platinum lead wires (L) were sealed into the ends of the switch as indicated. A minimum quantity of distilled mercury was placed inside the tubing to insure that the two lead wires at one end would be adequately covered and, thus, the circuit through them closed. The glass switch was evacuated and sealed off as shown.

The switch (S) was mounted by means of two small brass strips (C) to a brass plate (P), mounted on a brass base (B) by means of a pivot (A) which was made of a brass collar on a 1-inch, No. 10, 32-thread brass machine screw. The plate (P) and the base (B) were made of $\frac{1}{16}$-inch sheet brass.

In order to change from one thermocouple circuit to another, the driver (D), made from $\frac{1}{16}$-inch sheet brass, was attached to the driving wheel (W) on the shaft of a 1-r.p.m. motor. Obviously, any desired period of time for each circuit may be obtained by using a motor (M) with the desired r.p.m. or suitable reduction gears on an available motor. On this switch a Speedway motor,[2] No. 953-W, for 110-volt, 60-cycle alternating current, having a shaft speed of 1 r.p.m. was used. This afforded a 30-second cycle for each thermocouple circuit.

To insure the quick breaking of one circuit with the simultaneous quick closing of the second circuit, a steel ball (E), $\frac{3}{8}$ inch in diameter, was placed inside a $\frac{1}{2}$-inch brass tube (T), $1\frac{3}{8}$ inches long. The ends were crimped and the tube soldered on the back of the brass plate (P) as shown in Fig. 1. The extent to which the switch may be thrown in either direction is governed by the studs (X) upon which the brass plate (P) rests. These studs were made in the same manner as the pivot (A) previously described.

The wiring diagram for the thermocouple circuit is shown in the upper right-hand corner of Fig. 1. The two thermocouples are indicated by Y and Z; the recording potentiometer by R.

Very satisfactory results were obtained using this switch with one recording potentiometer to determine the temperatures of the heads of two gas fractionating columns operating simultaneously.

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[1] The author is indebted to A. E. Wood for suggested improvements in the original design of this switch.

[2] Manufactured by the Speedway Manufacturing Company, 1834 South 52nd Avenue, Cicero, Illinois.

Carbon 14 Production From Ammonium Nitrate Solution in the Chain-reacting Pile[1]

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Clinton Laboratories, Oak Ridge, Tennessee

It may be of interest to describe the method of production of the radioactive C^{14} currently being released by the Manhattan District in its isotope distribution program. C^{14} was discovered several years ago (*4*), and its general characteristics were correctly determined from weak samples resulting from prolonged cyclotron activation. These characteristics may be summarized as follows: (a) a half-life estimated as some thousands of years; (b) no gamma rays; (c) beta particles with a maximum energy of 0.14 Mev. In addition, it had been ascertained that C^{14} results from the reaction of neutrons with nitrogen—$N^{14}(n,p)C^{14}$, and that this reaction takes place under the action of slow neutrons (*1*). The latter property has become a particularly fortunate one since the advent of chain-reacting piles, with their great abundance of slow neutrons. Its significance is twofold: in the first place, samples thousands of times stronger than those which were made with great patience with the best cyclotrons can now be produced with relatively little effort, and, secondly, the C^{14} which results is (at least in theory) isotopically pure, since no other carbon is involved in the manufacturing process. Thus, a high level of specific activity is obtainable—always an important consideration, but particularly so when very long half-lives are involved.

Thus, the problem of manufacture becomes one of irradiating nitrogen in the pile and of subsequently separating the carbon. Although there are many ways of doing this, the choice is narrowed by practical considerations. For example, space economy demands that the nitrogen be in some form of high atomic density, and neutron economy demands that it should not be combined with elements which would contribute high parasitic neutron absorption. Furthermore, the nitrogen must not be in the form of a compound which will decompose badly under the radiation present in the pile. Also, the material should not contain, in combination or as impurities, elements which would lead to conflicting radioactivities such as would require special decontamination procedures.

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[1] Work done under the auspices of the Manhattan District.

[2] The assistance of E. P. Meiners, Jr., Miss T. I. Arnette, and F. Schuler is gratefully acknowledged. We consider ourselves honored to have been associated with the late Dr. Louis Slotin in the early phases of the work.

In our case, considerations of expedience also were important. At the time of the start of the work the occasion demanded an apparatus on the laboratory scale which would produce significant amounts of C^{14}, which would employ only readily available materials, and which would avoid the laborious process of "canning" material in welded aluminum jackets prior to irradiation. With these factors in mind, we chose to take advantage of the high water-solubility of ammonium nitrate and to build a solution "factory" which would work on the principle of continuous extraction. It was to be expected that most of the C^{14} would be evolved from such a solution in the form of gaseous compounds (*4*). Also, it was known that the decomposition of the solution by the radiation in the pile would produce a gentle stream of gaseous products, which might automatically provide a means of carrying the C^{14} out of the solution.

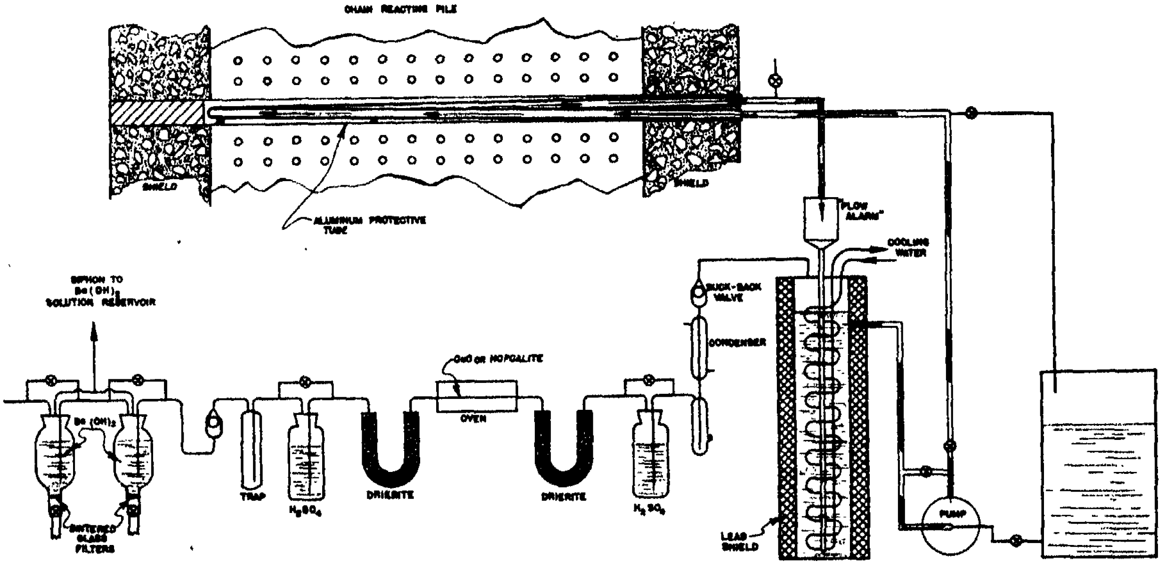

FIG. 1. C^{14} factory using circulating solution of ammonium nitrate.

The apparatus diagrammed in Fig. 1 was constructed upon a design intended to make the most of the automatic carrying and automatic purification inherent in these considerations. A glass centrifugal pump circulated the ammonium nitrate solution through a U-tube in the pile and then through a tall, lead-shielded vessel which served two purposes: (1) to provide a venting-off point for the gaseous products, and (2) to act as a heat exchanger so that the NH_4NO_3 solution might be cooled. A reservoir (shown at extreme right of figure) was used for occasional replenishing of the liquid or for storing the solution if the factory had to be emptied. The circulating system, constructed of aluminum, stainless steel, and glass, had a total volume of 55 l. The evolved gases which gathered above the liquid in the tall, lead-shielded vessel, were led off through a simple train containing drying agents, oxidizing agents, and, finally, bubblers containing barium hydroxide solution, in which the $C^{14}O_2$ precipitated as $BaC^{14}O_3$.

The factory was operated continuously, requiring only occasional inspection and removal of the $BaCO_3$ precipitate every few days. The gas stream ran at the rate of about 15 cc./minute, and measurements of its radioactivity showed that the extraction train was 99 per cent efficient. W. B. Leslie, of Clinton Laboratories, also analyzed the solution and found small fractions of C^{14} present as HCOOH, CH_3OH, and HCHO. From his data we have ascertained that these fractions comprise about 1 per cent of the total C^{14} collected. As might be expected, there is also dissolved in the solution a small residual amount of $C^{14}O_2$ which can be recovered easily by acidification. Tests also showed that practically no C^{14} was present in the form of the cyanide radical either in the gaseous phase or in the solution.

Mass spectrographic examination of some of the carbon from the factory was carried out by M. G. Inghram, of the Argonne National Laboratories. Dr. Inghram's results are reproduced in Fig. 2. The increase in the intensity of the mass 46 peak in the radioactive sample is quite spectacular. This peak is due mostly to $C^{12}O^{16}O^{18}$ in the normal CO_2 and mostly to $C^{14}O_2^{16}$ in the enriched material. Various considerations preclude the possibility that the increase can be due to disturbances in the normal abundances of the oxygen isotopes such as might, for example, lead to too much $C^{12}O^{16}O^{18}$. Quantitatively, Dr. Inghram's results showed that this sample contained C^{14} in an isotopic abundance of 3.3 per cent. When an absolute beta count was obtained on another portion of this sample, a value of about 5,300 years was obtained (*2*) for the half-life of C^{14}. This was in good agreement with the value of 4,700 years obtained by Reid, Dunning, Weinhouse, and Grosse (*3*) in an exactly analogous experiment with a different sample of C^{14}, which presumably also originated in our factory. For pure

C^{14}, this value of the half-life gives a specific activity of about 5 mc./mg.

The richest samples of C^{14} yielded by the factory had isotopic concentrations of 5.0 per cent. We have no satisfactory explanation as to the origin of the inactive carbon. Although some precautions were taken to remove $C^{12}O_2$ from the solution before charging it into the circulating system, we obtained large amounts of precipitate of lower specific activity during the first few days of bombardment. However, after the first week, the isotopic concentration of our product changed very little with long periods of irradiation, which might be interpreted as evidence that carbonate impurities and residual, dissolved $C^{12}O_2$ in the NH_4NO_3 solution could not be the only source of the inert carbon. We satisfied ourselves that no inward air leaks were present on the suction side of the pump, but apart from making these observations, we did not attempt to increase the isotopic purity; even 1 per cent is ample for almost all tracer experiments, and we were pleased that the specific activity was as high as it turned out to be.

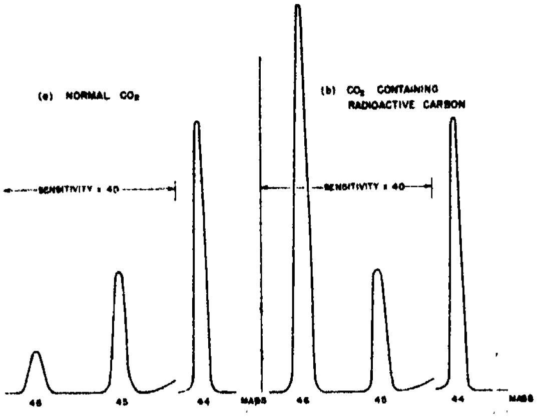

FIG. 2. Mass spectrograms of relevant peaks of normal and enriched CO_2 showing the great increase in the intensity of the mass 46 peak due to the presence of $C^{14}O_2^{16}$ in the enriched sample. The mass 44 ($C^{12}O_2^{16}$) peak is given on a scale equally reduced for the two samples. (Courtesy of M. G. Inghram.)

Some 50 mc. of the C^{14} made in this factory have been distributed in lots of 1 mc. or less to research institutions in the United States. The factory has now fulfilled its rather temporary function, and operation is being discontinued in favor of larger-scale production methods. There is a stock pile sufficient to carry over until the new methods come into quantity production. It is to be expected that in a year or so C^{14} will be so cheap and abundant that it will be more in the class of a commodity than that of a novel and treasured substance.

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A New Method of Recording Arterial Blood Pressure

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Virgil Hauenstein, and Harold J. Kersten

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A simple, accurate, and linear method of measuring intra-arterial blood pressure has been developed. Preliminary work indicates that this apparatus may prove to be of value in the measurement of other intraluminal pressures, such as those within the veins and in the subarachnoid space.

The apparatus consists of a Statham Pressure Transmitter[1] fitted with a short metal coupling which carries any gage needle. The transmitter operates on the strain gage principle and is enclosed in a metal housing measuring 1 x 1 x 3 inches. The input circuit is supplied by a dry cell; the output circuit is connected to the electrodes of any lead of a string-type electrocardiograph.

Before use the transmitter is calibrated against a mercury manometer, and a desirable range of excursion established by adjusting the string of the galvanometer or the input of the transmitter.

The coupling and needle are then sterilized by boiling, the transmitter filled with heparin (10 mg./cc.), and the coupling screwed into place. Enough heparin is displaced by this maneuver to fill the needle. All adjustments having been made, the vessel to be studied is punctured directly, and a photographic record of the movements of the galvanometer string is taken. The photograph in Fig. 1 illustrates a simultaneous recording by this instrument (A) and by the Hamilton manometer (B). The wide horizontal white lines represent millimeters of mercury as marked; the heavy vertical lines, intervals of 1/10 second.

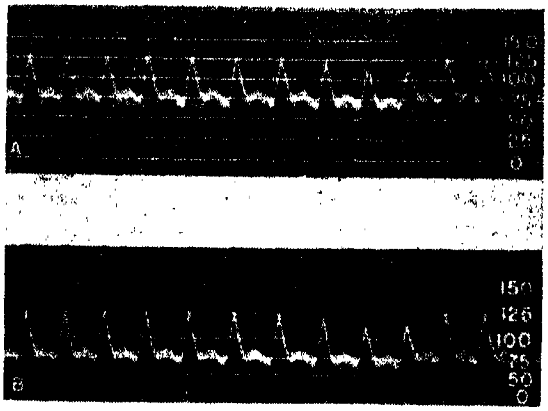

FIG. 1

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[1] Model P6-6g-250, manufactured by the Statham Laboratories, 8222 Beverly Boulevard, Los Angeles 36, California.

Book Reviews

The Trematoda: with special reference to British and other European forms. Ben Dawes. Cambridge, Engl.: at the Univ. Press; New York: Macmillan, 1946. Pp. xvi + 644. (Illustrated.) $10.50.

This book includes in one volume the more significant information from the literature on the Trematoda. It provides means for identification of the trematode parasites of representative animals of Europe and other countries. The treatment of North American literature on the group, although less complete than that of Great Britain, is extensive. The volume presents a more complete description of the structure, modes of life, bionomics, and life histories of the class than can be found in any single volume hitherto published. While not sufficiently complete to serve as a reference text for specialists on trematodes, it will be valuable to students, teachers, and research workers in their quest for relevant information on the members of this class. More specific information may be obtained from the approximately 1,600 titles cited in the list of literature, detailed references to the authors of which are given throughout the text. In this respect alone the volume is a very important contribution.

After brief treatment of the interrelations of the classes in the phylum Platyhelminthes, the author turns to the Trematoda and contrasts the life histories of Monogenea and Digenea, with examples. The taxonomic position of the order Aspidogastrea is discussed. Detailed descriptions of the external and internal structures in members of the Monogenea and Digenea are given to enable the reader to interpret the material dealing with the taxonomy of these forms. In the section on classification of Monogenea, a key to the suborders, superfamilies, and families is followed by a diagnosis of each group with further keys to the subfamilies under the diagnosis of each family. A similar but more comprehensive scheme is undertaken with keys and diagnoses of 47 families of the Digenea.

Three hundred pages list and describe the Monogenea of British fishes and Amphibia, the digenetic trematodes of British and some other fishes, some common Digenea of Amphibia and Reptilia, and some trematodes of birds and mammals. Many species are described and figured, and keys to genera with diagnoses and lists of species are provided. Many North American forms are included.

The author presents the larval types of the Digenea with descriptions of specific examples and ample illustrations. The different types of life histories of Trematoda are described and their reproduction, geographical distribution, and phylogeny discussed.

The book is stimulating and suggests many opportunities for further research. Particularly is this true in the section on the biology of the Trematoda, where the author introduces some of the problems concerning the fundamental physiological processes of trematode larvae.

A special effort is made to use scientific names correctly and to eradicate the confusion that has in some instances resulted from their misuse. The book contains seven comprehensive tables and hundreds of illustrations, some new and some redrawn from various authors. Cross references appear throughout the text, which is completely indexed.

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Scientific Book Register

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Programs for Medicine and National Health in the USSR

Stuart Mudd, ***President of the American-Soviet Medical Society*** **and**
Professor of Bacteriology, Medical School, University of Pennsylvania

OPPORTUNITY FOR OBSERVATIONS IN 20 medical institutions and for acquaintance with some 200 professional persons was afforded Robert L. Leslie, Mrs. Mudd, and myself in the course of a visit to the Soviet Union between the middle of August and the middle of September 1946. Arrangements for the trip were initiated by Dr. Leslie in behalf of the American-Soviet Medical Society and the *American Review of Soviet Medicine*. Our official hosts were Vladimir Kemenov, president, and A. Karaganov, vice-president, of VOKS, the Society for Cultural Relations With Foreign Countries, and their courteous staffs. Medical facilities were made open to us, particularly through V. V. Parin, secretary-general of the Academy of Medical Sciences of the USSR and vice-president in charge of the Medical Section of VOKS, and N. N. Priorov, vice-minister of Public Health of the USSR.

The warmth, friendliness, and openness of our professional colleagues in discussing matters of common interest were intensely gratifying. We found the Soviet scientists, who were eager to have us see, understand, and appreciate their work, far better acquainted with the technical literature of western Europe and America than our scientists are with Soviet material. The standard journals were seen in Soviet institutional libraries and were obviously read with understanding.

The attitude of our Soviet colleagues was not a result of lack of realization that the political atmosphere was surcharged with tensions: our lay press is also available in Soviet libraries, and their press is outspoken with respect to political issues. Their attitude is determined, we believe, by tragic and personal experience of suffering, loss, and deprivation caused by the war, by a profound need for peace and security in which to rebuild their country and to provide the necessities and the niceties of life, and finally, by a realization that the scientists' world is, indeed, one. And, of course, Soviet scientists have the very human desire to know their colleagues elsewhere and to be known and appreciated by them.

Progress in the Study of Higher Nervous Activity—Relationships to Mental Health

Evidences of the myriad ramifications of the work of the great Pavlov and his school were among the most interesting scientific activities observed. Pavlov worked until his death in the physiological laboratory of the Institute of Experimental Medicine, Leningrad, founded in 1890 and the oldest institute of its kind in Russia. Pavlov's laboratory, with a staff of 11 people, is now in charge of P. S. Kupalov. Rooms for the experimental study of conditioned reflexes and operating rooms are in active use, and pictures concerning Pavlov's association with the late Walter B. Cannon are prominently displayed. Experimental studies conducted even during the war have been published in the *Transactions* of the Physiological Laboratory of Pavlov, and Prof. Kupalov has in preparation a monograph in extension of Pavlov's writings.

Pavlov, feeling the need for more space, built a small laboratory in Koltushi, a suburb of Leningrad, and asked the government for 1,000,000 rubles for its support. He received 12,000,000 rubles. Building of the extensive laboratories and of the community now known as Pavlova was begun in 1929. After Pavlov's death in 1936, at the age of 86, the institute at Pavlova was put in charge of Academician L. A. Orbeli, who decided to undertake the study of the evolution of the nervous system on a large scale. The institute thus became the Institute of Evolutionary Physiology and Pathology of Higher Nervous Activity. This now has a staff of 90 workers, with 45 more in the associated clinic for the study of children. The administrative office is decorated with pictures of Sechenov, Claude Bernard, Johannes Müller, Darwin, Huxley, Sherrington, and the Georgian physiologist, Torchanishvili.

Study of the activities of the nervous system at many levels of the phylogenetic scale are in progress at Pavlova. There we were privileged to meet E. Ganicke, for 40 years a collaborator of Pavlov, who has studied the comparative physiology of the conditioned reflex and has repeated in mice Pavlov's work with dogs. Prof. Ganicke stated that he had been able to demonstrate conditioned reflexes even in insects and in mollusks, though obviously at a primitive level. Under other investigators work is proceeding on a monkey colony, and behavior of children is observed at an associated clinic.

Ontogenetic development receives equal attention at Pavlova. The comparative development of the neuromuscular apparatus and its behavior is under study in embryos and newborn of various animals. Effects of altered environmental conditions, such as O_2 and CO_2 tension, blood sugar level, etc. during embryonic development, are also studied.

An abridged version of this report, which was presented before the American Philosophical Society in Philadelphia, October 19, 1946, appears in the *Proceedings of the American Philosophical Society*, 1947, 91, 181–188.

Development of nervous activity during the maturing of rabbits, mice, rats, guinea pigs, dogs, monkeys, and humans is under investigation. The cerebral cortex has been found to be relatively undifferentiated functionally in the newborn. The work at Pavlova has demonstrated that in nervous activity, as in morphology, "ontogeny recapitulates phylogeny."

The inheritance of higher nervous functions in genetically known lines of dogs is also under investigation. The "nursery for dogs' children" is well designed and obviously the object of scrupulous care.

M. K. Petrova, for 25 years a collaborator of Pavlov, is one of the most creative of his school. She has achieved much of Pavlov's original intent of imitating experimentally in animals characteristic pictures of neuroses and psychoses as they occur in man. Volume 12, 1945, of the *Transactions* of the Physiological Laboratory of Pavlov, which she presented to us, contains eight of her own articles, covering 221 pages. Summaries are in English. Experimentally induced phobias in dogs are described. Weakening of inhibitory processes in the central nervous system is shown to be an indispensable condition for the appearance of such phobias. The nature of the phobia is closely connected with some event previously experienced by the dog and strongly affecting it. The weakening of the inhibitory process could be brought about and the phobia made manifest by prolonged overstrain, prolonged use of conflicting conditioned reflexes, or chronic alcoholization of the animal. Following amelioration of the conditions cited, phobias disappeared as soon as nervous equilibrium was restored.

Dogs have also been observed over many years in which anxiety states produce trophic disturbances of the skin. Continuous observation of one dog throughout six years "showed that trophic disturbances in the form of extensive exudative eczema appeared every time her nervous activity weakened under prolonged periods of daily work which was beyond her strength." Easing of the work and rest to restore weakened nervous activity resulted in complete restoration of nervous equilibrium, together with healing of trophic lesions. Such anxiety neuroses and their accompanying skin dystrophies also responded well to prolonged sleep induced by veronal or hypnosis. Relapse was induced by the prolonged action of alcohol. Further detailed studies are presented by Petrova on the effects on the higher nervous activity and symptomatology of dogs of varying nervous constitutions of prolonged administration of thyroid extract, alcohol, bromine, caffeine, and other drugs. Some of this material is in preparation for detailed publication in the *American Review of Soviet Medicine.*

Other outgrowths of the work of the Pavlov institutes were seen at Sukhumi, in Georgia, near the Black Sea. Here an extensive primate colony is maintained as a biological experiment station of the Academy of Medical Sciences of the USSR. The director, L. G. Voronin, is a former member of Pavlov's staff. Many aspects of physiology, psychology, and pathology of these primates are studied in comparison with similar aspects in man. A remarkable feature is the study of behavior under natural conditions, in great enclosures of natural tropical jungle. We were particularly interested in the observations of relationships of mothers and young in *Macacus rhesus* monkeys and in an "orphanage" of motherless macaques. These little "orphans" were under the care of a former school teacher, and their remarkable confidence in her was reminiscent of the relationships of trust and kindness between children and teachers in the Soviet nurseries and schools visited.

To what extent are all these comparative studies of nervous activity contributing to the practical management of mental disease and to the securing of mental health? An American psychiatrist, K. E. Appel, has recently written:

> Modern psychiatry rests to a great extent on the work of three men: a Russian, an American, and an Austrian. The importance of the emotions, and their effect on the biological organism, was brilliantly studied by Walter Cannon. The organization of responses and the conditions of learning were ingeniously investigated and worked out by Pavlov in his studies of the conditioned reflex. The *effects* of conditioning or training, both parental and social, on the development of the human personality were the contributions of Freud (*Amer. Rev. Soviet Med.*, 1946, **3** (Suppl.), 32-39).

V. A. Gilyarovski, director of the Institute of Psychiatry in Moscow, when asked a similar question during our visit to that institution, replied that the contributions of the Pavlov school were of the greatest importance to practical psychiatry and that the physiological approach to mental disease, in his opinion, was definitely more valuable than the Freudian. Physiological and chemical work is particularly cultivated in this Institute. Great attention is also paid to psychiatric work with children.

The great importance of psychiatry has become even more manifest in the USSR since the end of the war. Dr. Gilyarovski stated that functional disturbances of the nervous system did not increase in the Red Army during the war. This he attributed to the high morale (the wholehearted devotion of the troops to the defense of their country), the good attitude of the officers, and the low rate of infectious diseases in the Red Army. The incidence of endogenous psychiatric illnesses has not increased since the war's end. That of functional disturbances of the nervous system did increase in places under German occupation and has increased in general since the end of the war. When a person is in high spirits, said Dr. Gilyarovski, he can do everything better than when he is depressed and upset, but after a period of prolonged nervous strain comes a period of reaction. Dispensary care at an early stage is particularly important for the care of men in the period of reaction following demobilization.

Particular attention is being paid to preventive and early treatment of mental illness. Small hospitals and dispensaries are being built near railroad stations and in centers of population throughout the Soviet Union for purposes of early treatment, and many cures are obtained. A capacity of 100–150 beds is considered optimal for mental hospitals. Separate hospitals are provided for children and for epileptics. Nurses attend the patients who do not require clinic care but do require care in homes. Particular attention is bestowed on veterans and those who were under bombing. There are at present about 60,000 beds for chronic mental cases in the Soviet Union but 100,000 are desired.

The value in securing mental and emotional health of conditioning to kindness, security, and group solidarity was illustrated in a remarkable way at the Institute for Pediatrics in Leningrad. This is a training school of pediatric medicine, offering a 6-year course from secondary school to graduation, and a postgraduate course of 3-6 months integrated with a children's hospital. There are about 2,000 students, mostly women, and about 1,000 child patients. The proportion of male students has, however, been increasing since the end of the war. Research, care, and teaching all proceed within the same institution, and children long confined to the hospital even have school in the wards. The director, M. A. Mendeleva, stressed the particular importance of kindness and understanding in working with children. During the siege of Leningrad the hospital was for months under direct bomb- and shellfire. Five hundred stoves were made and installed in the Institute to replace the central heating, which was demolished by the bombing. During the summer vitamin needs were met by growing blackberries, raspberries, etc. on the hospital farm and preparing syrups from them. According to Dr. Mendeleva, there were no neuroses among the patients during all this time. This she attributed to the confidence of the patients in those who cared for them, the calmness of the staff, and the fact that nothing was ever permitted to interrupt the routine.

Consideration of programs safeguarding mental health in the Soviet Union cannot be adequate without at least brief reference to the care and training of children in nurseries, kindergartens, and schools. There was a conscious and successful effort to make every child feel secure in being wanted and loved and in having a place in the group. The older children also had a sense of responsibility to their communities and took it as a matter of course that they would contribute to the needs of their communities by active personal work. The excellent program of child care makes possible active participation in work by women with families.

To what degree the conditioning of children to kindness, group participation, and responsibility is traditional and to what degree it is a conscious adaptation of psychological principles, we do not know. At all events, it impresses us as basically sound mental hygiene.

COMMUNAL HYGIENE

The Institute of Public and Communal Hygiene in Moscow, which was founded in 1931 and included in the Academy of Medical Sciences in 1945, suffered a great deal during the war. Repair is still not complete, and equipping is under way. The Institute has 9 divisions and 12 laboratories as follows: (1) Division of Air Hygiene and Town Planning, in which there are two laboratories: Microclimate and Air Study; (2) Division of Water Hygiene, Water Supply, and Canalization, with two laboratories: Study of Drinking Water and Study of Sewer Water; (3) Division of Soil Hygiene and Purification of Towns, including two laboratories: Soil Study and Helminthological Study; (4) Division of Hygiene of Dwellings and Public Buildings, with its two laboratories: Lighting Hygiene, and Conditioning, Heating, and Ventilation; (5) Division of Personal Hygiene and Customs, in which there are two laboratories: Study of Clothing and Articles of Personal Hygiene; (6) Division of Bacteriological Sanitation, with a laboratory; (7) Division of Physiology, with a laboratory; (8) Division of Organization Methods, Consultation, and Examination; and (9) Division of Municipal Statistics and Legislation.

The Institute staff comprises 14 professors with the M.D. degree, 29 senior scientific workers, 22 junior scientific workers and specialists, 6 postgraduate students, 25 scientific auxiliary personnel, and 35 business personnel—131 persons in all. The director is A. N. Sysin.

The problems upon which the Institute works, as presented to us in writing by E. A. Bragin, the assistant director, are given below, together with some observations noted during our round of the laboratories.

(1) Sanitary consequences of the war: (a) re-establishment of Stalingrad—expedition into Stalingrad with a staff of 6 scientific workers; (b) dwellings in the re-establishment period; and (c) cleaning cities in periods of war and subsequent times.

A landscape architect was at work with large maps of Stalingrad, major buildings, parks, etc. Particular attention was being given to discovering the optimal relation of parks and recreation centers to the distribution of the population and to the planting of trees in the city. The design and location of buildings with respect to air currents and ventilation was under consideration. Formulation of optimal hygienic conditions in town planning is being sought. A book is now in press on the planting of trees in cities.

(2) Acclimatization: (a) population in Arctic conditions—expedition to Dikson Island with a staff of 3 persons; (b) clothing and conditions in different climatic zones.

Study of the influence of the microclimate of cities on persons is carried out by observation of the condition of meteorological factors in 5 points of the city of Moscow with meteorological statistics. The problem is an explanation of the hygienic problem of creation of the most suitable microclimatic conditions in different parts of the city, depending on the function of these parts, by means of planning and planting trees in the city. The laboratory establishes special methods for outer districts for the purpose of massive carrying out of observations.

The study of acclimatization of persons is carried out in different climates of the USSR by special programs, both for local institutes and also a special expedition into the Arctic. The expedition visits Dikson Island, Igarku and a series of points on the shore of the Karsky Sea. The study referring to conditions, morbidity and meteorological factors gives a great amount of material which has been obtained in these places in a series of years.

(3) Pollution of atmospheric air: (a) dust pollution in relation with meteorological factors and the significance of planting trees in the regions where the air is full of dust; (b) bacteriological pollution of the air and its sanitation.

The influence on the process of self-purification of air by filtration through planting trees is seen in different regions of Moscow and it is seen in places significantly covered with dust as well as those little covered with dust in different seasons of the year.

Studies are carried out on the characteristic processes of self-purification and pollution of air by the method of study of the loss of solar radiation and its specific participation depending on change in content of aerosols and micro-elements of the air medium.

A theory of normal pollution of the air is being developed for establishing different origins of pollution, for establishing city standards of planning for the purpose of different types of businesses.

Detailed studies are conducted with regard to fuels, wind velocity, humidity, temperature, etc. in relation to the smokes and fumes from specific installations in Moscow and Stalingrad and with regard to better methods of stoking, precipitation, etc.

We saw apparatus for the collection of dust on oiled slides supported in vertical and horizontal planes on a weather vane device, and a portable device containing batteries, fan, flowmeter, and cotton strainer for collecting and weighing dust.

With regard to ridding the air of confined spaces of its pathogenic microorganisms, work was proceeding along the lines in progress in the United States but was at a relatively early state of development in the Moscow laboratory. A simple infection chamber was available in which bacterial aerosols were sprayed and the killing action of ultraviolet radiation and germicidal vapors was under investigation. Vapor of fir balsam was reported to be germicidal and that of certain vinyl ethers bactericidal in a concentration of 0.1–0.2 mg./l. of air. "The activity (of this vinyl ether) is not found to be dependent on the humidity of the atmosphere, and therefore this preparation is preferred above triethylene glycol (Robertson)." A 6,000-volt electroprecipitator is reported to be a sensitive detector of bacteria in air.

(4) Pollution and self-purification of water: (a) reservoirs and sanitary conditions of them—expedition to Klyazminsky reservoir (water station) with a staff of 8 scientific workers; (b) manufacture of sewerage water and its significance in pollution of water.

Charts of bacterial counts of the Moscow water supply since 1937 indicated that these counts were high when the water was derived chiefly from the Moscow River but had been lower in recent years with water coming mainly from the Volga.

Stress was laid upon a method of bacteriological sampling in which the water was filtered through a collodion membrane held in a filter of Seitz type. The membrane was then removed, laid on the surface of an endo-agar plate, and incubated. *Escherichia coli* colonies of characteristic appearance grew out in the membrane. A member of the staff described this and other "Russian methods" and said proudly, although with some embarrassment, that these were the reasons American standard methods of water analysis had not been adopted.

(5) Sanitary indications of soil pollution.

In the laboratory of soil hygiene it was explained that, during the siege of Stalingrad and in other circumstances of prolonged deprivation of protein during the war, the colon bacillus flora of the feces of the human population was greatly reduced.[1] Many bacteria with typical biochemical reactions of *Aerobacter aerogenes* appeared in the feces under these circumstances.

The work carried out in the Soviet Union and in part by the Institute of Hygiene indicates complete absence from soil not polluted by persons or animals of both *A. aerogenes* and *E. coli*; and that either is an indication of some sort of pollution. Thermophiles are also used as indicator organisms for animal and human fecal pollution. The thermophilic organisms resulting from human fecal pollution have a lower temperature tolerance—up to 60° C.; those of some animal feces tolerate 60° or above.

Detailed description of the studies of these laboratories regarding sanitation, mineralization of organic matter, and microbic antagonisms in the soil will not be attempted here.

(6) New sources of lighting and their sanitary purposes.

The Division of Hygiene of Dwellings and Public Buildings has existed in the Institute from the day of its beginning in 1931. The Division consists of: (a) laboratory for the hygiene of special and artificial lighting; (b) laboratory for the hygiene of heating, ventilation and air conditioning in which there are special chambers for microclimate with the use of conditioned air. The staff of this Division is 14 persons. The chief of the Division is Professor S. I. Vetonkin, M.D.

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[1] Those who have read Simonov's *Days and nights* may appreciate the spirit of people who investigate the intestinal flora under the appalling conditions of Stalingrad.

The Division has as its basic problems the working out of hygienic problems for scientific basic planning, outfitting and improvement of dwellings and public buildings:

(a) Study of microclimate of reserved spaces (study of village buildings, air ventilation, large buildings, etc.). At the present time there is experimental study of few-storied buildings in Stalingrad, Moscow and abroad with the Division working on hygienic problems of normal dwellings, inner outfitting and arrangement of dwellings in the post-war period (expedition to Stalingrad and abroad).

(b) Study of climatic lighting and the physiological-hygienic basis of the method and norm of natural and artifical lighting of closed dwellings and open spaces. In the pre-war years, the laboratory of hygiene of lighting worked on the questions of: (1) lighting of schools, (2) lighting of medical establishments, (3) lighting of dwellings and (4) climatic light in Moscow. In subsequent years the laboratory is attacking the study of new sources of light (luminescent lamp) in a hygienic relation—physiological-hygienic purpose of luminescent lamp of low pressure mercury arc and also sterilamp (bactericide).

In the current year one doctor completes a dissertation under the direction of the laboratory of hygiene of dwellings on the theme: "Hygienic basis for lighting schools"; besides this, post-graduate students have carried out dissertations in collaboration with the Division on the theme: "Hygienic requirements for lighting medical institutions."

(7) History of hygienic thought in the USSR until the Revolution and in Soviet times.

(8) Network of scientific study and sanitary-prophylaxis establishments in the USSR.

(9) Home and municipal legislation in relation to sanitation and further perspectives.

(Continued in next week's issue.)

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Social and Economic Sciences (K): Successor to Albert E. Waugh (resigned) not yet announced.

History and Philosophy of Science (L): Raymond J. Seeger, Bureau of Ordnance, Navy Department, Washington, D. C.

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Education (Q): Dean A. Worcester, University of Nebraska, Lincoln, Nebraska

Chemical Research Conferences, 1947:

Colby Junior College, New London, New Hampshire, June 16–August 22

W. George Parks, *Director,*
Rhode Island State College, Kingston

THE CHEMICAL RESEARCH conferences, organized on a continuous basis by Dr. Neil E. Gordon in 1938 and formerly known as the Gibson Island Research Conferences, are sponsored by the AAAS. Gifts from industrial companies whose laboratories have been represented at the Conferences provided the funds with which the AAAS purchased the Conference property on Gibson Island, located in Chesapeake Bay a few miles south of Baltimore, Maryland.

During the past nine years the Conferences have been held each summer on Gibson Island, the facilities of the Gibson Island Club being made available to those attending. However, in recent years it has not been possible to provide satisfactory accommodations for the increased number of persons desiring to attend the Conferences because of the limited facilities available and because of the expanding activities of the Club, which required greater use of its facilities for Club members.

The Management Committee of the Conferences therefore decided this year to dispose of the Gibson Island property and to move to a location with greater facilities and more suited to the specific needs of the group.

LOCATION

The Chemical Research Conferences for 1947 will be held at the Colby Junior College, located in the New England vacation country, in New London, New Hampshire. The entire facilities of the College have been made available for the Conferences. Concord, the state capital, is 35 miles to the southeast, and Hanover is the same distance to the northwest. By automobile, New London is located on the cross-state highway, Route 11, 100 miles from Boston and 130 miles from Springfield, Massachusetts. The White Mountains are approximately 50 miles from the College.

There are two ways of reaching the College by train: From Boston, those attending the Conferences should take the Boston and Maine Railroad to Potter Place, which is a short distance by automobile from New London; from New York City and the West, New London is reached via Springfield, Massachusetts, and Claremont Junction, New Hampshire. Concord, New Hampshire, is the nearest airport and is served by the Northeast Airlines. Limited bus transportation is also available. The College owns and operates three station wagons, primarily for transportation to and from the railroad stations.

There are six mountains in the skyline and numerous lakes in the immediate area. Opportunities are available for many sports, including golf (Lake Sunapee Golf Course), tennis (six composition courts and a practice board), swimming (fresh water), and boating. Numerous other recreational facilities are available for relaxation during the Conferences.

PURPOSE

The Chemical Research Conferences were established to stimulate research in universities, research foundations, and industrial laboratories. This purpose is achieved by an informal type of meeting consisting of scheduled lectures and discussion of topics of current research interest.

The first meeting of each Conference is held Monday at 10:00 A.M. Other morning sessions through Friday are usually scheduled from 9:30 A.M. to 12:00 Noon. The second session of each day is generally held from 7:30 to 10:00 P.M., Monday through Thursday. There are no Friday evening sessions, and Conference members are expected to release their rooms not later than Sunday morning.

ATTENDANCE

Those interested in attending the Conferences are requested to send in their applications to the director, on or before April 15. Each applicant must state the institution with which he is connected and the type of work in which he is most interested.

The director will submit the names of those requesting attendance to the chairmen of the respective Conferences. Each chairman, in cooperation with a Program Committee, will review the names and select the members in an effort to distribute the requests as fairly as possible among the various institutions represented. Names selected by the program committee will be returned by the chairman to the director, who will notify those selected. A registration card will be sent with the notice of selection. For each Conference advance registration by mail is required. On receipt of the registration card and the registration fee of $3.00, made payable to the Chemical Research Conferences, a room assignment will be sent to each registrant. In addition to the registration fee, a deposit to cover the room rent for the number of days of attendance must accompany the registration card. Rooms are $4.00 per day per person; the meals served in the College dining room, $4.50 per day per person. During each Conference a buffet dinner is planned for Thursday evening at no additional charge. If possible, single rooms will be made available for the speakers at the same rate. Several suites will be available at the rate of $5.00 per day per person, with a minimum of two persons per suite. Unallocated suites will be assigned to man and wife whenever possible. On proof that the member is paying his own personal expenses, he may be granted a reduction of $1.00 per night on room rent. This information should be given at the time a request for attendance is made. The registration fee will not be refunded. The deposit to cover the room will be returned and room reservation canceled, provided notice of inability to attend is received in sufficient time to rent the room.

Accommodations will be available for a limited number of women who wish to accompany their husbands. All such requests should be made at the time of the request for attendance, since these limited accommodations will be assigned in the order of receipt of specific request.

Requests for attendance at the Conferences or for any additional information should be addressed to Dr. W. George Parks, Department of Chemistry, Rhode Island State College, Kingston, Rhode Island.

PROGRAM

Organic High Polymers

C. C. Price, Chairman; W. O. Baker, Vice-Chairman

June 16 C. S. Marvel, "New Monomers"; R. L. Frank, "Structure of Synthetic Rubbers."

June 17 G. S. Whitby, "Proliferous Polymerization"; John Rehner, Jr., "The Polyisobutylene Reaction."

June 18 A. J. Warner, Federal Telecommunication Laboratories, "New Monomers"; H. Mark, "Cyclo-octotetraene."

June 19 A. V. Tobolsky, "Aging and Degradation of Polymers"; E. H. Farmer, British Rubber Producers Association (title to be announced).

June 20 M. G. Evans, The University, Leeds (tentative).

Catalysis

Walter G. Frankenburg, Chairman; H. S. Taylor, Vice-Chairman

June 23 Aristid V. Grosse, "The Concept of Catalytic Chemistry"; H. S. Taylor, "New Data on the Heterogeneity of Catalytic Surfaces."

June 24 James B. Sumner, "The Chemical Nature of Biocatalysts; Problems Concerned With the Isolation of Enzymes"; Paul H. Emmett, "Adsorption of Carbon Monoxide and Hydrogen on Carbided Iron Catalysts."

June 25 Otto Beeck, "Thermodynamic and Mechanical Statistical Aspects of Catalysis"; Thomas W. DeWitt, "Mechanism Studies with C^{14} on Iron Fischer-Tropsch Catalysts."

June 26 M. Jellinek, I. Fankuchen, R. Ward, and M. Erchak, "X-Ray Diffraction in the Study of Catalysts" (tentative); Marion Armbruster, "The Sorption of Gases on a Plane Surface of Stainless Iron-Chromium-Nickel Alloys at 20°, 78°, and −185°C."

June 27 Herman E. Ries, Jr., "Adsorption Studies of Some Supported Catalysts and Their Supports."

Petroleum

W. G. Lovell, Chairman; O. Beeck, Vice-Chairman

June 30 F. D. Rossini, "Hydrocarbons in Petroleum"; S. S. Kurtz, "Analysis of Petroleum Products for Hydrocarbon Types."

July 1 H. M. Smith, "Survey of Composition of American Petroleums"; A. C. Fieldner, "Synthetic Fuels and Shale Oil."

July 2 Clark Goodman, "Physical and Chemical Changes Produced by Nuclear Radiations"; A. M. Rothrock, "Power Production From Petroleum."

July 3 J. R. Bowman, "Theory of Distillation and Related Separation Processes"; Manson Benedict, "Diffusion Separation Processes."

July 4 O. Redlich, "Azeotropic and Extractive Separations."

Textiles

W. A. Sisson, Chairman; Ross C. Whitman, Vice-Chairman

July 7 Eugene Pacsu, "The Molecular Structure of Cellulose and Its Relationship to Chemical Degradation"; Clifford B. Purves, "Some Aspects of the Chemical Reactivity of Cellulose."

July 8 Onslow B. Hager, "The Reaction of Cellulose With Formaldehyde Compounds and Its Effect on Fiber Properties"; John A. Howsmon, "The Fine Structure, Moisture Regain, and Physical Properties of Rayon."

July 9 Alfred E. Brown and Milton Harris, "Natural Protein Fibers"; Harold P. Lundgren, "Synthetic Protein Fibers."

July 10 Charles F. Goldthwait, "The Swelling of Cotton and Its Utilization in Water-resistant Fabrics"; Harold DeWitt Smith, "Properties of Woven Fabric as Anticipated From Fiber Properties."

July 11 Earl K. Fischer and Charles H. Lindsley, "Rheological Properties of Compositions Used in the Textile Industry."

Corrosion

K. G. Compton, Chairman; I. A. Denison, Vice-Chairman

July 14 H. H. Uhlig, "The Electrochemical Theory of

Corrosion"; R. B. Mears, "Factors Affecting the Rate of Atmospheric Corrosion."

July 15 W. S. Loose, "Atmospheric Corrosion of Light Metals"; R. H. Brown, "Atmospheric Corrosion of Light Metals"; A. W. Tracy, "Atmospheric Corrosion of Nonferrous Metals"; W. E. Campbell, "Indoor Atmospheric Corrosion of Nonferrous Metals."

July 16 Harry R. Copson, "Atmospheric Corrosion of Iron and Ferrous Alloys"; C. H. Sample, "Atmospheric Corrosion of Metallic Protective Coatings."

July 17 I. A. Denison, "Underground Corrosion"; R. B. Hoxeng, "Cathodic Protection of Underground Structures by Means of Light Metals."

July 18 R. L. Starkey, "Bacteria and Underground Corrosion."

Medicinal Chemistry

E. H. Northey, Chairman; J. M. Sprague, Vice-Chairman

July 21 Enzyme Chemistry.

July 22 Antibiotics.

July 23 Curare and Curare-like Drugs; Folic Acid.

July 24 Veterinary Medicine.

July 25 Tuberculosis.

The speakers and titles on the Conference subjects will be announced in the final program, to be published April 1, 1947.

Vitamins

D. W. Woolley, Chairman; Floyd S. Daft, Vice-Chairman

July 28–August 1 P. L. Harris and E. L. Hove, "Treatment of Experimentally Induced Stomach Ulcers With Tocopherol"; H. R. Bird, "Studies on an Unknown Growth Factor in Cow Manure"; C. A. Cary and A. M. Hartman, "I. Evidence of the Existence of a Still Unidentified Growth Factor in the Nutrition of the Rat. II. Relation Chemically and Nutritionally to Protein, and Occurrence in Variously Prepared Caseins and Other Sources of Protein"; W. E. Knox, "Identification of New Metabolites of Nicotinic Acid"; D. M. Bonner, "The Precursors in the Biosynthesis of Nicotinic Acid"; J. Schultz and G. T. Rudkin, "The Requirements for Growth of *Drosophila* on a Chemically Defined Medium"; W. D. Salmon, D. H. Copeland, and R. W. Engel, "Production of Neoplasms as a Result of Prolonged Choline Deficiency."

The program for the Conference on Vitamins is incomplete. Additional speakers with titles and the specific dates will be given in the final program, to be published April 1, 1947.

Food and Nutrition

Lawrence Atkin, Chairman; P. L. Harris, Vice-Chairman

August 4–August 8 M. L. Anson, "Sugar-Protein Reaction, Significance and Methodology"; Speaker to be announced, "Chemistry of the Sugar-Protein Reaction"; Discussion leader, J. P. Kass. Speaker to be announced, "Food Anti-Oxidants, Fat-Soluble"; Speaker to be announced, "Food Anti-Oxidants, Water-Soluble"; Discussion leader, P. L. Harris. Gerald J. Cox, "Caries and Nutrition in Human Subjects"; James H. Shaw, "Nutrition and Animal Dentition"; Discussion leader to be announced. K. P. Richter, "Self-Selection of Foods"; H. Waelsch, "Nutrition and Brain Function"; Discussion leader, to be announced. A. White, "Nutrition and Endocrine Function"; Paul György, "Diet, Liver and Sex Hormones"; Discussion leader to be announced. Speaker to be announced, "Intestinal Microorganisms and Human Nutrition"; L. Wright, "Intestinal Microorganisms and Animal Nutrition"; Discussion leader to be announced. Speaker to be announced, "The Clinical Estimation of Nutritional Status"; Speaker to be announced, "Results of Postwar Nutritional Surveys"; Discussion leader to be announced. D. K. Tressler, "Enzymes in the Food Industry"; Z. I. Kertesz, "Pectins and Pectic Enzymes"; Discussion leader to be announced. H. H. Mitchell, "Evaluation of Proteins and Hydrolysates *in Vivo*"; R. J. Block, "Evaluation of Proteins and Hydrolysates *in Vitro*"; Discussion leader, D. Melnick.

The completed program for the Food and Nutrition Conference will be published April 1, 1947.

Cancer

A. M. Brues, Chairman; Paul S. Henshaw, Vice-Chairman

The preliminary program for the Cancer Conference is not yet available. The final program will be published April 1, 1947.

Instrumentation

C. O. Fairchild, Chairman; J. C. Peters, Vice-Chairman

August 18 Robert B. Jacobs, "High-Vacuum Measurement and Control"; R. L. Garman, "Physical Properties Not Commonly Used in Indirect Measurement"; C. M. Albright, Jr., and C. H. Neilsen, "Unsolved Control Problems of the Chemical Industry."

August 19 Ralph H. Müller, "Electronics in Modern Analytical Chemistry"; Donald P. Campbell, "Practical Application of Automatic Control Theory; Ralph E. Clarridge, "The Organization and Functions of an Application Engineering Department."

August 20 Norman Wright, "Application of Infrared Measurements in Industry"; John J. Grebe, "Application of Control Principles to Human Behavior."

August 21 James J. Lingane, "Polarography"; J. C. Mouzon, "Low-Temperature Radiation Pyrometry in Industry."

August 22 W. J. Eckert, "Field of Usefulness of Various Mechanical and Electrical Calculators."

NEWS *and Notes*

Late Friday, March 7, the Interstate and Foreign Commerce Committee of the House ended the current hearings on the National Science Foundation Bills. A score of witnesses presented testimony, some urging that the four House Bills, 1815, 1830, 1834, and 2027, which are identical with the Senate measure, S. 526, analyzed last week in *Science*, be adopted. Others, particularly those representing the administration, seemed to favor the Celler Bill, H.R. 942, calling for a single responsible officer appointed by the President.

One witness, Frank B. Jewett, advised against any Foundation. He said that the present shortage of private funds for fundamental research in the sciences was only temporary, due to the existing tax structure, and that he thought that a small change in the tax laws would make private funds again available in sufficient amounts. In taking a position against the Foundation he continued his stand of a year ago in the Senate hearings as the only person to testify against some form of Federal subsidy for research.

When asked by the Committee specifically about this solution, President Conant replied that he thought it was "indirect" and that immediate measures should be taken to discover scientific talent among young people and to provide for their basic science education through scholarships.

President Conant also said that he thought there had been entirely too much concern over the proposed organization and administration of the bills, that he personally would be satisfied to see any of them made a law. He held that the patent issue was separate and should not be a part of final congressional action. He also preferred the wider latitude permitted in the four identical bills, where the social sciences are not specifically mentioned but the Board is permitted to increase the number of Divisions to include "other sciences."

The questions of the Committee were designed to get clear statements on the controversial points: type of administration, single administrator or board; patent provisions; and inclusion of the social sciences. To a lesser extent questions were directed to finding out whether witnesses favored some mandatory geographical distribution of funds.

The complete testimony from the official record will not be available for some time, so that an analysis of each witness's stand on these controversial points cannot now be made. In some cases no clear-cut classification will be available even then, because some witnesses avoided a direct answer to the question.

Others among those who testified were Edmund E. Day, representing the newly-formed Inter-Society Committee for a National Science Foundation (Science, March 7); Robert Patterson, Secretary of War; Adm. P. F. Lee, director, Office of Naval Research; Thomas Parran, Surgeon General; Caroll L. Wilson, representing the Atomic Energy Commission; William C. Foster, Undersecretary of Commerce; Detlev Bronk, National Research Council; Randolph T. Major, director of research and development, Merck & Company, Inc.; Robert M. Yerkes, Social Science Research Council; Bruce Brown, Standard Oil of Indiana; John F. Victory, National Advisory Committee for Aeronautics; W. A. Higinbotham, Federation of American Scientists; Vannevar Bush, Joint Army-Navy Research Board; and George E. Folk, National Association of Manufacturers.

Statements from Representatives Celler and Mills, Isaiah Bowman, and Homer Smith were inserted in the record without reading.

Following an all-day meeting of the Executive Committee of the new Inter-Society Committee for a National Science Foundation, March 5, Dael Wolfle, secretary-treasurer, announced that Isaiah Bowman and W. Albert Noyes, Jr. had found it impossible to serve as members of the Committee. The remaining members, Edmund E. Day, Harlow Shapley, Ralph W. Gerard, and R. G. Gustavson, unanimously agreed on the following statement, which became part of Dr. Day's testimony at the House hearing, March 6:

(1) The Foundation must provide for the support of basic fundamental research without reference to the development of immediate practical applications.

The many striking applications of technology during the war tend to give a misleading impression of the progress of science. Wartime "discoveries," such as radar, magnetic detection of submarines, and even the atomic bomb, were simply the exploitation of long-established scientific principles. Radar, for example, is a straightforward modification of radio. And radio is the practical use of the discoveries made by Hertz in the middle of the last century. During the war virtually all basic research came to a halt as scientists and laboratories concentrated on engineering and development for immediate uses. We must have a National Science Foundation to replenish our stockpile of basic scientific knowledge.

(2) The Foundation should be free to investigate problems in any scientific area and by any appropriate method, for it is impossible to determine in advance which problems will lead to fruitful results and which methods will be successful.

Twenty years ago who would have thought that the study of molds would lead to the development of the wonder drug, penicillin? Fifty years ago, in searching for the missing element, radium, Madam Curie had no thought or foreknowledge of its many useful applications.

(3) The Foundation should provide for the training of young scientists to make up the great shortage of scientific personnel that now exists due largely to the fact that students who would normally have begun their scientific careers were taken for military duty.

(4) The Foundation should provide for the coordination of scientific research and the development and utilization of scientific personnel. It should integrate its work with that of other government agencies, should be free to plan the development of new laboratories when necessary, and should become responsible for the continuation of the National Roster of Scientific and Specialized Personnel. The Foundation should feel a responsibility and have authority to survey continuously the country's scientific needs and assume leadership in planning ways to meet those needs.

The administrative machinery necessary to accomplish these aims was one of the controversial points in the bills considered last year. There is no unanimity of opinion among scientists as to the most desirable administrative setup. The specific organization should be planned with the help of experts in government and administration. There is a very widespread feeling among scientists that the caliber of men chosen to direct the National Science Foundation is much more important than the details of administrative organization. It is our feeling that the bill should not be so specific in details of procedure and organization as to hamper the administration in carrying out the objectives of the Foundation. Competent administrators, well acquainted with scientific problems and with the full confidence of the Government and their scientific colleagues, can create an effective National Science Foundation.

President Conant's testimony, which will be printed in full in *Science* next week, centered about the following points:

(1) The welfare of a free society in an industrial age depends on a continuous advance of science and the application of the new knowledge to useful ends.

(2) Both the advance of science and the application of science to industry, to medicine, and to agriculture depend on the quality and quantity of scientists and engineers available in a nation.

(3) The supply of men depends on the number trained and the innate ability of those who undertake the special training.

(4) The scientific professions in question require a long and expensive education beyond high school.

(5) This education is of such a nature that it can be given at only a relatively few centers in every state.

(6) Therefore, unless a student lives in one of these centers, his professional training must be costly, for he must pay for room and board away from home as well as other expenses.

(7) The consequent financial barrier now prevents many boys and girls of high ability from going on with an advanced education. Much talent is lost to the Nation by this educational waste.

(8) To right the balance, a Federally-supported scholarship and fellowship program is required.

President Truman paid a surprise visit to the project exhibits of the 40 contestants in the 6th Science Talent Search, Saturday, March 1. The President appeared at the Statler Hotel at the dinner hour. Refusing to interrupt the dinner, he spent a half-hour in the company of his aides viewing the exhibits. The President specifically requested officials to provide him with a detailed report on the present whereabouts and status of the winners of the previous five Searches conducted annually under the auspices of Science Service for the Westinghouse Science Scholarships.

About People

Walter M. Gilbert retired on March 1 as executive officer of the Carnegie Institution of Washington after 42 years of service. Since 1905, three years after establishment of the Institution, he has been a central figure in the operational and administrative conduct of its affairs. During the war years he served as representative of the Institution in its contractural relationships with government agencies.

The new executive officer is Paul A. Scherer, formerly chief of the engineering and transition office, OSRD.

Henry W. Smyth, professor of physics, Princeton University, is presenting a summary of progress in atomic physics during the past half-century, in connection with the Sigma Xi National Lectureships, during March. Following are the universities at which he will speak and the dates: Baylor University, March 25; Tulane University, March 26; and The University of North Carolina, March 28. On March 3, 5, 6, and 7 Dr. Smyth spoke at the University of Nevada, Brigham Young University, University of Utah, and Utah State Agricultural College, respectively.

William E. Rand, Sun Chemical Corporation, New York, has been appointed assistant director of the Stanford Research Institute, Stanford University, California. He will also act as project manager for the Natural Rubber Research Project being conducted by the Institute for the Office of Naval Research.

Mary Evans Maxfield, assistant professor of physiology, Mt. Holyoke College, has been appointed to the staff of the Department of Pharmacology and Therapeutics, Wayne University College of Medicine, Detroit, Michigan.

Barry Commoner, medical and biological editor of *Science Illustrated* since May 1946, has resigned from the editorial staff.

Norman Q. Brill has been appointed professor and director of the Department of Neurology, Georgetown University School of Medicine, Washington, D. C. Dr. Brill, who taught at Columbia University and engaged in private practice in New York before the war, is at present consultant and assistant chief of neuropsychiatry, Veterans Administration, Washington, D. C.

William Roger Sloat, television engineer, Columbia Broadcasting System, New York, has been appointed instructor in engineering, Institute of Geophysical Technology of St. Louis University.

W. E. Carroll, head of the University of Illinois Department of Animal Husbandry since 1939 and member of the Agricultural College staff since 1925, has been appointed associate director of the Agricultural Experiment Station. He will be responsible for coordination and routine administration of several hundred research projects under way at the Station.

Clarence A. Discher, formerly acting head of the Chemistry Department, Oshkosh, Wisconsin, State Teachers College, has been appointed assistant professor of chemistry, Rutgers College of Pharmacy.

H. H. Remmers, director, Division of Educational Reference, Purdue University, Lafayette, Indiana, has accepted an invitation to lecture on educational measurement and evaluation in the summer session of the University of British Columbia, Vancouver, July 2–August 15.

R. B. Cattell, chief surgeon of the Lahey Clinic, Boston, and W. E. Gallie, professor of surgery, University of Toronto, recently addressed members of the University of Texas Medical Branch, Galveston, Texas.

Virginia C. Dewey, formerly of the chemical research staff of Lever Brothers, Cambridge, Massachusetts, is now research associate in microbiology at Amherst College, Amherst, Massachusetts.

James O. Foley has been made professor of anatomy and chairman of the department, Medical College of Alabama, Birmingham, Alabama. Dr. Foley went to Alabama from Tulane University, where he had been from 1925 through 1930. He replaces C. N. Goss, who recently went to Louisiana State University School of Medicine as chairman of the Department of Anatomy.

Clarence J. Hylander, former staff officer with the Naval Air Training Command and head, Botany Department, Colgate University, has joined the Macmillan Company as visual aids editor in their College Department.

Alfred S. Romer has been appointed Alexander Agassiz professor of zoology at Harvard University. Director of the Museum of Comparative Zoology, curator of Vertebrate Paleontology, and professor of zoology, Prof. Romer joins Henry B. Bigelow, curator of Oceanography, and Frank M. Carpenter, curator of Fossil Insects, who also held Agassiz professorships, established in 1944 under the will of Alexander Agassiz, who was in charge of the Museum of Comparative Zoology until his death in 1910.

James Bordley, III, associate professor of medicine, Johns Hopkins University School of Medicine, has been appointed director of the Mary Imogene Bassett Hospital, Cooperstown, New York, to succeed George M. Mackenzie. Dr. Mackenzie, for 20 years physician-in-chief and director of the hospital, will retire September 1, 1947.

Francis E. Johnstone, Jr., professor of horticulture and vegetable breeder, Alabama Polytechnic Institute, Auburn, has been appointed geneticist for the Educational Service of the National Cottonseed Products Association. Dr. Johnstone, who has been associated with the Institute since 1940 except for wartime service in the Navy, will cooperate with research institutions in encouraging production of cotton high in oil content and other oilseed crops in cotton states.

Hobart M. Smith, Department of Fish and Game, Texas A. and M. College, College Station, has been appointed assistant professor of zoology at the University of Illinois, Urbana.

Ralph L. Shriner will become professor and head of the division of organic chemistry, Department of Chemistry, State University of Iowa, Iowa City, in September 1947. He is now chairman of the Department of Chemistry, University of Indiana, Bloomington, a post he has held since 1941.

Grants and Awards

The Federated Societies for Experimental Biology will grant five travel awards of $500 each to younger scientists in the physiological field who wish to present papers before the 17th International Physiological Congress at Oxford, England, July 22–25. Awards will be made to scientists 35 years of age or younger, who submit outstanding contributions in physiology for presentation.

Membership in one of the Federated Societies will not influence selection for an award. Until March 22 applicants may address letters to Maurice B. Visscher, Secretary, American Physiological Society, 318 Millard Hall, University of Minnesota, Minneapolis 14, enclosing seven copies of an abstract of his or her paper and an equal number of copies of a curriculum vitae and bibliography. Applicants should also send the names of two to four scientists competent to evaluate their work.

The Agricultural and Mechanical College of Texas, College Station, Texas, has received the following research grants: $6,000 for two research fellowships from the Heil Company, Milwaukee, Wisconsin, and gift of a portable dehydration unit for hay and grain drying and a mechanical harvester; $15,000 from Swift & Company to the Texas Agricultural Experiment Station for support of a three- to five-year study supplementing investigations initiated by the Station and the U. S. Department of Agriculture on methods of applying phosphorus to cattle by application of fertilizers and by feeding; $5,000 from John W. Carpenter, Dallas, Texas, for work on artificial insemination of dairy cattle; and $250 from the Texas Restaurant Foundation to assist students in commercial dietetics at Prairie View University for Negroes, a branch of Texas A. & M.

C. Clayton Hoff, assistant professor of zoology and parasitology, Colorado A. & M. College, has been awarded a grant of $200 by the American Academy of Arts and Sciences for ecological work on plant and animal associations at various altitude levels in Colorado.

The Roscoe B. Jackson Memorial Laboratory has received a grant of $15,000 from the John and Mary R. Markle Foundation to be used over a two-year period for developing electronic devices for measurement of emotional and physiological reactions. The work will be in charge of John L. Fuller.

Fellowships

Battelle Memorial Institute, Columbus, Ohio, has announced openings for a limited number of predoctoral Fellows and postdoctoral Associates to conduct scientific and engineering investigations in Battelle laboratories during the year beginning in the summer or fall of 1947. Appointees will devote full time to their own research projects in Battelle laboratories under the guidance of the Battelle technical staff.

Fellowships are open to men seeking the Doctor's degree in a science or engineering and are available normally for the final year of graduate study. Fellows receive a stipend of $1,200 a year plus allowances for supplies, equipment, traveling, and other expenses.

Associateships are open to young men who have completed their academic training and have shown exceptional aptitude for research as graduate students or in subsequent employment. The stipend of an Associate is adjusted to his preparation, experience, and promise.

Inquiries may be addressed to the Institute, 505 King Avenue, Columbus 1, Ohio.

General Electric Company recently granted research fellowships totaling $20,500 to 14 graduate students for advanced study in electricity, physics, physical chemistry, and engineering.

The American Telephone and Telegraph Company has awarded 1947–48 Frank B. Jewett fellowships for research in the physical sciences to the following: M. G. Ettlinger, California Institute of Technology, also a 1946–47 fellow, in chemistry; Wallace D. Hayes, California Institute of Technology, physics; Paul Olum, Harvard University, mathematics; Aadne Ore, Yale University, physics; Alfred Schild, Carnegie Institute of Technology, physics; Robert L. Scott, University of California, also a 1946–47 fellow, chemistry; and Edwin H. Spanier, University of Michigan, mathematics.

The fellowships, founded three years ago on retirement of Dr. Jewett, vice-president in charge of development and research, carry an annual stipend of $3,000 to the holder and $1,500 to the resident institution, and are normally available only to scientists who have recently received doctorates or are about to receive them.

The University of Maryland has been granted a fund by the Bartlett Tree Research Laboratories, Stamford, Connecticut for study of nematode diseases of ornamental plants. The grant will provide a graduate assistantship in the Department of Botany beginning July 1.

Colleges and Universities

The University of Rochester Division of Engineering, Rochester, New York, announces the following new administrative appointments: John H. Belknap, chairman of the Department of Electrical Engineering; Howard G. Gardner, chairman, Department of Chemical Engineering; and Horace W. Leet, chairman, Department of Mechanical Engineering. The Division of Engineering, created in 1945 as an expansion of the former Department of Engineering, has an enrollment of 400 students, nearly double the prewar number.

A new $500,000 Navy research contract for the development of a synchrotron was announced by Edmund E. Day, president of Cornell University, March 5. The new instrument is to be housed in a small structure north of Bailey Hall, adjoining the proposed new building for the Laboratory of Nuclear Studies. The new synchrotron will be approximately 12 feet in diameter and contain nearly 70 tons of special transformer iron. It is expected to accelerate electrons to 300,000,000 electron volts, sufficient to produce mesons.

Meanwhile, new methods of studying high-energy particles are being developed at the Cornell Laboratory as completion of the synchrotron is awaited. It is hoped that some of these may be tested in cosmic-ray study before the machine is ready for use.

The production and study of mesons is only one of the experiments planned for the synchrotron. Experimental verification of some of the present theories making conflicting predictions about the behavior of electric forces in the ultra-high energy region will be possible.

Researchers at present are making use of the slow neutron velocity-measuring equipment, again in operation with the Cornell cyclotron after being loaned to the Los Alamos Laboratory. New results have been obtained recently on the scattering of slow neutrons in water.

A new staff of physicists has been assembled at the University's Laboratory of Nuclear Studies. In addition to Director Robert R. Wilson (*Science*, February 21), others include Hans A. Bethe, recently head of the Theoretical Physics Division, Los Alamos; Lloyd P. Smith, now chairman of Cornell's Departments of Physics and Engineering Physics, and associate director of the RCA Laboratories, Princeton, during the war; L. G. Parratt, formerly head of the Engineering Division Research Unit, Naval Ordnance Laboratory; K. I. Greisen, of the Los Alamos staff; B. D. McDaniel, of the Radiation Laboratory, M.I.T.; Richard P. Feynman, formerly of Princeton, and a group leader in the Theoretical Physics Division, Los Alamos; Philip Morrison, senior physicist at the Metallurgical Laboratory, Chicago, and at Los Alamos; and Dale R. Corson, of the Radiation Laboratory and the Los Alamos staff. New research associates are Charles P. Baker, Ernest D. Courant, John W. DeWire, and Charles D. Swartz, all of whom had important wartime assignments.

Franklin A. Long, of the Cornell Department of Chemistry, who has returned after three and one-half years with OSRD, will also be a member of the group. Other additions to the staff are expected. Robert F. Bacher, former head of the Laboratory of Nuclear Studies, is presently serving on the U. S. Atomic Energy Commission (*Science*, November 8, December 13 and 20).

Industrial Laboratories

Eli Lilly and Company, Indianapolis, Indiana, has appointed the following to the Research and Control Function: Royce Buck, University of Minnesota, Analytical Department; Ralph Truax, Purdue University, Antibiotics Manufacturing Division; and Mary Jane Ward, Iowa State College, Organic Chemistry Division.

Bausch & Lomb Optical Company announces opening of a manufacturing plant at Wellsville, New York, and purchase of the four-story Navy Building on Champeney Terrace, Rochester, New York, as part of its $6,000,000 modernization program. At present 400 employees are producing eye-glass lenses and television optics in the Navy Building, which was leased to Bausch & Lomb during the war.

E. I. du Pont de Nemours & Company, Wilmington, Delaware, has announced the following organizational changes in the Technical Division of the Rayon Department: Hood Worthington, assistant director, Engineering Research Section, Wilmington, was made assistant director, Nylon Research Section, Wilmington, and W. L. Hyden, assistant director, Cellophane Research Section, Buffalo, New York, was promoted to director of personnel, planning, development, and patent service, Wilmington.

Other appointments are: F. H. Swezey, senior research associate, acetate process rayon plant, Waynesboro, Virginia; G. P. Hoff, director of acetate research, and G. M. Karns, director of cellophane research, Wilmington; W. W. Heckert, director, and E. W. Spanagel, assistant director of cellophane research, Buffalo; W. C. Eberlin, assistant director of new fibers research, Waynesboro; C. E. Miller, manager of cellulose acetate research, Waynesboro; R. A. Hentschel, manager of pioneering research, Buffalo; F. R. Millhiser, manager of viscose rayon research, Richmond, Virginia; and R. F. Conaway, assistant director of the Acetate Research Section, Waynesboro.

Meetings

The Southeastern Section of the Botanical Society of America, Inc., will hold its 4th annual meeting at Emory University, Georgia, April 18–19, with the Association of Southeastern Biologists and the Southern Appalachian Botanical Club.

The Federation of American Societies for Experimental Biology will meet in Chicago beginning May 18, William H. Chambers, Federation secretary-treasurer, has announced. The Federation is composed of the American Physiological Society, American Society of Biological Chemists, American Society for Pharmacology and Experimental Therapeutics-American Society for Experimental Pathology, American Institute of Nutrition, and American Association of Immunologsist.

The Pittsburgh Geological Society will hold a symposium on the Trenton and Sub-Trenton strata of the Appalachian Area May 16 at the William Penn Hotel, Pittsburgh. Papers will be presented at morning and afternoon sessions, and a banquet will be held in the evening.

The purpose of the symposium is to bring together all information possible on the Trenton and Sub-Trenton rocks of the Appalachian Basin from the surface section on the eastern and northwestern outcrop belt to the subsurface section across the Basin as interpreted by well records and sample studies. The stratigraphy, structure, and economic aspects of this portion of the geological column will be correlated for the entire Appalachian Basin.

John T. Galey is chairman of the symposium committee.

Elections

The Oregon Academy of Science elected the following officers at its 5th annual meeting in Portland, Oregon, January 17–18: R. R. Huestis, Eugene, president; Warren D. Smith, Eugene, vice-president; F. A. Gilfillan, Corvallis, secretary; and Pierre Van Rysselberghe, Eugene, treasurer.

The southern section of the American Society of Plant Physiologists elected the following officers for 1947: O. A. Leonard, Mississippi State College, chairman; Ivan E. Miles, North Carolina Department of Agriculture, vice-chairman; and Henry C. Harris, Florida Agricultural Experiment Station, secretary-treasurer. H. P. Cooper, Clemson College, South Carolina, E. M. Emmert, University of Kentucky, and S. F. Thornton, Norfolk, Virginia, were elected members of the executive committee.

A new insecticide, TEP, which will kill some important insect pests not affected by DDT, has been announced by Leo R. Tehon, acting chief, Illinois Natural History Survey.

Disclosure was made by George F. Ludvik, working in the Natural History Survey laboratories on a Monsanto Chemical Company fellowship under George C. Decker, entomologist of the Natural History Survey and the Illinois Agricultural Experiment Station.

The new insecticide, tetraethyl pyrophosphate, which for brevity can be shortened to TEP, has been unusually effective in laboratory tests against aphids and mites, destructive crop pests difficult or impossible to control by DDT. The shortage of nicotine, the poison usually relied upon for control of aphids on peas, apples, potatoes, peaches, and other crops, makes discovery of TEP especially important at this time, Dr. Decker pointed out. Laboratory tests indicate that it is more than 10 times as toxic to aphids as nicotine alkaloid.

TEP was discovered in studying an extensive series of phosphorus compounds. It has been found to be approximately three times as toxic to insects as hexaethyl tetraphosphate, an insecticide developed by the Germans during the war as a substitute for nicotine.

An advantage of TEP, Dr. Decker explained, is that it does not appear to leave a poisonous residue. Tests being conducted indicate that this product will decompose within a few days after application, and food products on which it is used may not need to be washed before marketing.

Before being employed on the Monsanto research project, Mr. Ludvik served 40 months in the Army Medical Corps. He was graduated and received his Master's degree from the University of Illinois and is continuing graduate study and research on insect pests of crops.

A letter from Oscar Orias, Córdoba, Argentina, indicates that a private institution for research in the fundamental branches of medicine, Instituto de Investigación Médica para Promoción de la Medicina Científica, has been organized with private funds in Córdoba. Dr. Orias, director of the Institute, was at one time traveling fellow of the Rockefeller Foundation, working at Western Reserve and Harvard Universities. On the staff are Enrique Moisset de Espanes, who was at Harvard University in the same capacity, and Inés L. C. de Allende, who visited the University of Rochester.

Dr. Orias writes: "We all had to resign our positions in the Institute of Physiology in the Medical School of the University of Córdoba on account of the situation created in the Argentine Universities by the Perón regime."

The new Institute, he said, will be devoted to research in endocrinology, pharmacology, and physiology of the circulation of the blood. The address is 25 de Mayo 1122, Córdoba.

Recent Deaths

Horace A. Shonle, 54, director of the organic chemical research division of Eli Lilly & Company, Indianapolis, and authority on barbituric compounds, died February 24 following a brief illness. Mr. Shonle discovered amytal in 1924 and was later responsible for the discovery of seconal.

A. R. Mann, 66, agricultural economist and former provost of Cornell University, died on February 21 in New York City upon his return from a special assignment in Europe for the War Department.

Lily Bell Sefton Deatrick, 63, professor of chemistry, West Virginia University, Morgantown, died November 25 in Morgantown. She is survived by her husband, Eugene P. Deatrick, also of the Department of Chemistry, West Virginia University.

Make Plans for. . .

Crystallographic Society, 2nd annual meeting, March 19–21, U. S. Navel Academy, Annapolis, Maryland.

Western Metal Congress and Exposition, fifth, March 22–27, Civic Auditoriums, Oakland, California.

American Association of Petroleum Geologists, 32nd annual meeting, March 24–27, Los Angeles, California.

Midwest Power Conference, March 31–April 2, Palmer House, Chicago.

American Association of Anatomists, annual meeting, April 3–5, Mount Royal Hotel, Montreal, Canada.

Institute of Mathematical Statistics, meeting on stochastic processes and noise, April 24–25, New York City.

COMMENTS
by Readers

Elementary zoology books and descriptive handbooks, some of comparatively recent date, retain the use of semantically poor thermal terminology. Similarly, inadequate or even misleading statements are used to describe the body temperature of reptiles. It is commonly stated, for example, that "reptiles have the temperature of the surrounding air." This is only vaguely true. It would seem desirable to eliminate both the semantic difficulty and the misleading statements in new and revised editions of the books.

Birds and mammals are usually referred to as warm-blooded organisms, partly because they are capable of maintaining temperatures that are ordinarily higher than that of the circumambient air, and partly because of the assumption that bird and mammal temperatures are higher than those of the so-called cold-blooded animals. Because temperatures of the air or the substratum on occasion may be higher than the body temperatures of the "warm bloods," the term loses some of its force. However, it is particularly misleading when the usage implies that modern reptiles habitually operate at lower body temperatures than the mammals. Most diurnal lizards function within an optimal range of 36–42°C. (R. B. Cowles. *Amer. Nat.*, 1940, **75,** 542–561; R. B. Cowles and C. M. Bogert. *Bull. Amer. Mus. nat. Hist.*, 1944, **83,** 265–296), which is fully as high as that of many mammals and more than equals the temperature of the more primitive birds. By this criterion, some birds, and probably no mammals, are entitled to the term warm blooded.

Wherever the terms warm blooded or cold blooded are replaced by the descriptive terms homoiotherm and poikilotherm, the concepts evoked are more *nearly accurate*, but it is still misleading because many lower vertebrates living in caves, all tropical fishes, and completely aquatic amphibia and reptiles are all probably *more nearly homoiothermic* than are many birds and mammals. In both groups of homoiotherms there are forms in which seasonal or diurnal fluctuations are characteristic physiological traits. In fact, all birds exhibit considerable rhythmic diurnal fluctuations, and many hibernating mammals as well as monotremes, marsupials, and at least some edentates are characterized by one or another type of temperature variation.

Although the nature of organisms defies our attempts to place them in unvarying categories, the most significant thermal difference between the poikilotherms and homoiotherms is the major reliance of the so-called warm-blooded animals on endogenous, internally generated sources of heat. It is for this reason that these animals were originally given the term endotherm. Conversely, since the cold-blooded animals derive practically all of their effective heating from outside the body, where it is absorbed either directly from the sun (heliothermic types) or indirectly through contact with adjacent substances (thigmothermic types), collectively they were designated as ectotherms. It is believed that the use of these terms evokes a more accurate concept of the real differences underlying the thermal physiology than do the words in current use.

Possibly as a result of the semantic inadequacy of the older terms, it is customary to state that the cold bloods—that is, the poikilotherms—live at the temperature of their environment. In a broad sense this is true, but it is misleading. The body temperature of the ectotherm is derived from its environment, which in diurnal species consists of the sunlight, the substratum, and to a less extent the circumambient air. Furthermore, if the animal is moving, the environment will differ from moment to moment. The extent to which a broad statement can be meaningless is illustrated by the following extreme example. A small lizard, *Uta stansburiana hesperis*, was captured on a windy day while it was basking in a rock crevice exposed to full sunlight. The air temperature was 13°C., but the cloacal temperature was 38°C. In this case the temperature of the lizard was the product of the environment, which consisted of the heat absorbed from the sun, heat loss to the rock on which it was perching, and to a lesser extent loss to the air. A closer analysis undoubtedly would have revealed that the air film on the lizard's body was somewhat less than 38°C., and that the air 1 mm. away would have been cooler, while that at a foot or two away would be nearer 13°C., the temperature of the uninterrupted stream of air. (R. B. Cowles, *University of California, Los Angeles*, and C. M. Bogert, *American Museum of Natural History, New York.*)

The issue of *Science* for August 2, 1946, appropriately printed a letter by Edward J. Van Liere, pleading the cause of new physiological terminology, and suggesting a distinction between asphyxiate and anoxiate. I have for some time considered the possibility of two coined words that should be of use to medical entomologists.

Transstadial. Terminology of the relationship of insects and their allies to harbored disease organisms has in the past been encumbered with such awkward terms as "stage-to-stage transmission," "generation-to-generation transmission," or the inappropriate "hereditary transmission" of disease agents in their arthropod hosts. Lately the descriptive phrase "transovarial transmission" has come into increasing favor in reference to passage of the agents from one generation to the next. As a corollary, the term "transstadial transmission" should also be concise and useful as denoting persistence or passage of such agents through the various stages of a given generation of the host. "Interstadial" would be more euphonious but less exact in combination with "transmission."

Nosarthrology. The recent war has emphasized the important field of medical entomology having to do strictly with arthropods as vectors of disease agents. The recently evolved word "virology" is a somewhat parallel case in the broader field of bacteriology. "Nosarthrology" is suggested as an appropriate term for the science of transmission of disease agents by insects and their allies which could be used in a more restricted sense than the broader current conception of medical entomology. (Col. Cornelius B. Philip, *U. S. Public Health Service, Hamilton, Montana.*)

TECHNICAL PAPERS

Effects of 2,4-D on Seed Germination and Respiration

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Synthetic plant-growth-promoting substances, known also as auxins, have been found to possess many practical applications in agriculture. They have been extensively used to prevent premature shedding of fruits, to induce rooting of cuttings, to induce parthenocarpy and ensure fruiting, to keep the bud in dormancy, and to improve the well-being of a plant in general (*4*). The reasons for the versatility of auxin treatment are still being conjectured. Only at very high dilutions (1 ppm) does indole acetic acid promote growth and accelerate protoplasmic streaming in the *Avena* coleoptile; at slightly higher concentrations (10–100 ppm) it depresses growth, stunts the plant, but induces root formation; and at still higher (100–1,000 ppm) it becomes destructive to chlorophyll and to the plant as a whole (*1*). The recent successful introduction of di- or trichlorophenoxyacetic acid, a compound which possesses high auxin activities, as a translocated herbicidal spray by F. D. Jones and others has amply revealed the importance of this new phase of research on auxin treatment. Furthermore, it has been shown that the herbicidal effect of this and allied chemicals on plants can be differential and selective, *i.e.* it can be applied effectively in the field to kill some major weeds while leaving the crops unharmed (*2*).

The facts that 2,4-D can be actively absorbed by, and freely translocated in, the plant before the latter is killed, and that its lethal effect on plants can be differential, seem to us most interesting and deserving of some physiological investigation.

Germination of seeds involves many of the physiological and biochemical processes exhibited in mature plants, such as the breakdown and translocation of the stored food, the formation of seedling organs, and the high respiratory and metabolic activities during germination. If a chemical compound happens to be injurious to certain plants and if it happens to be involved in inhibiting some specific metabolic activity therein, its physiological effect can be conveniently put to test by treating germinating seeds with such a chemical, the dosage of which may be easily controlled. Various kinds of seeds, differing in structure, in their principal food constituents, and in their biochemical behavior, can be employed for the test. These differences may be expected to manifest themselves through differences in their reaction toward a given chemical treatment. This procedure was employed by us to study the physiological action of 2,4-D on plants. The chemical treatment of seeds usually results in a complete inhibition of, or a substantial delay in, germination, which, on refined analysis, may reveal some specific metabolic disturbance in the seeds.

Seeds of barley and rice were first chosen as test materials. These cereal grains, which are more or less alike in structure and food content, differ physiologically in that rice excels in fermentative faculty and is alone able to germinate in the absence of oxygen (*3*). Seeds of uniform size and appearance were selected from the pure line stock kindly furnished us by the Department of Plant Pathology, Tsing Hua University, and then divided into lots of 100 seeds each. The different lots of seeds were treated with various dilutions of 2,4-D ranging from 0.0035 to 0.1 per cent. After 24 hours of treatment, each lot of seeds was thoroughly washed with water to remove the adhering chemical and put in a labeled Petri dish in which a moist filter paper had been placed. The Petri dishes were assembled in a moist chamber maintained at 25 ± 2°C. and the rate of germination of the seeds followed at suitable intervals. As long as the filter paper in the dish is kept moist, addition of excess water is avoided. In these experiments the criterion for germination used by Taylor (*3*) was adopted, *i.e.* seeds were regarded as germinated when any organ had attained a length of not less than 1.5 mm. The subsequent growth of the seedling was not included in our observations. The 2,4-D employed in these experiments was synthesized in our laboratory.

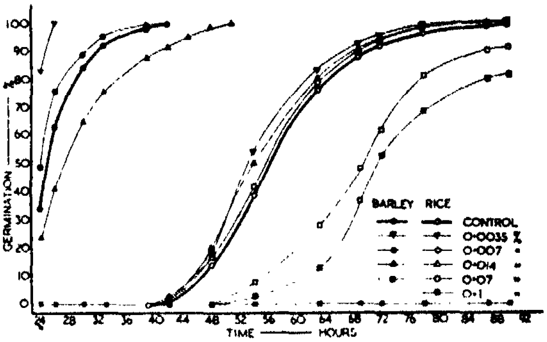

Fig. 1. The germination of barley and rice as affected by treatment with different concentrations of 2,4-D.

The rates of germination of the treated seeds are plotted in Fig. 1. Similar to other auxins, 2,4-D accelerates seed germination at low concentrations but delays it when a certain threshold of concentration is exceeded. The outstanding feature of our results is that the threshold concentration in retarding germination is higher in rice (ca. 0.07 per cent) than in barley (ca. 0.01 per cent). Furthermore, 0.07 per cent 2,4-D inhibits barley germination completely while it merely delays germination in rice. Even when the concentration is raised to 0.1 per cent, 2,4-D fails to prevent the rice from germinating, though it delays the process still further. Comparison of the germination rate of seeds treated with 2,4-D with that of seeds kept under aerobic and anaerobic conditions reveals a striking resemblance between the treated seeds and those under anaerobic condition. It seems as if oxygen were no longer available to the treated seeds, so that the germination of barley, a typical aerobic seed, is entirely inhibited and that of rice, a seed known to be able to germinate anaerobically, is only duly delayed. Fig. 2 illustrates this point very well. The anaerobic condition was attained by flushing the container of the germinating seeds with nitrogen.

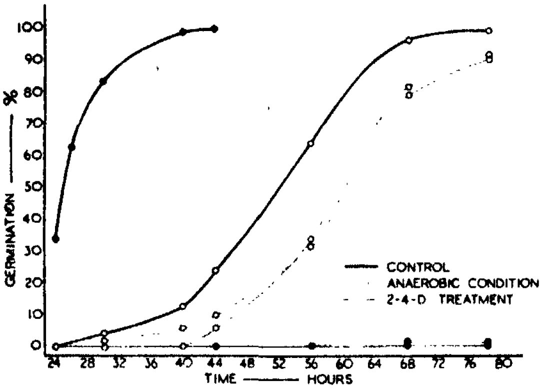

FIG. 2. Influence of 2,4-D treatment (0.1 per cent) and anaerobiosis on germination of barley and rice (barley = ●; rice = ○).

The same procedure was extended to various other types of seeds—those which store their food in cotyledons (legumes) and those rich either in proteins (soybean) or in fats (*Raphanus*). Table 1 summarizes our findings. With the exception of sesame seeds, which may have a lower threshold of inhibition than the concentration employed, the results seem to substantiate our view regarding 2,4-D treatment.

For a final proof, gas exchange in the treated seeds of barley and rice was analyzed with Warburg microrespirometers. The aerobic (respiration) and anaerobic (fermentation) activities of the treated seeds during germination were calculated from the data on the assumption that the aerobic respiratory activity of the treated seeds was the same as that of the control, *i.e.* in both barley and rice, the R. Q. value is close to unity. The respiratory intensity was represented by CO_2 evolved in aerobic respiration, the value of which was obtained in the case of treated seeds by subtracting fermentation CO_2 from the total CO_2 evolved. The results are presented in Table 2. All values given are relative.

TABLE 1

	Percentage germination under anaerobic condition	Percentage germination of seeds treated with 0.1% 2,4-D
Rice	100	100*
Barley	0	0
Wheat	0	0
Soybean	0	0
Broad bean	0	0
Peanut	0	0
Raphanus	8–10	20–30*
Sesame	15–20	0

* No subsequent growth.

TABLE 2

RESPIRATORY ACTIVITIES OF BARLEY* AND RICE† TREATED WITH 0.1 PER CENT 2,4-D DURING EARLY PERIOD OF GERMINATION

Time (days)	Seeds	Experimentally determined				Calculated from values on experimentally determined activities				
		O_2 uptake		CO_2 evolution		Respiration CO_2 evol. (%)	Fermentation CO_2 evol. (%)	Fermentation CO_2 evol./Respiration CO_2 evol.	$CO_2:O_2$	Respiratory intensity Treated/Untreated
		Total	Treated/Untreated	Total	Treated/Untreated					
					Barley					
1st day	Untreated	12.0	0.33	11.0	1.36	100	—	—	0.92	0.34
	2,4-D-treated	4.0		15.0		33	103	3.12	3.75	
2nd day	Untreated	17.0	0.30	16.0	0.94	100	—	—	0.94	0.29
	2,4-D-treated	5.0		15.0		29	65	2.24	3.0	
3rd day	Untreated	57.0	0.21	52.0	0.30	100	—	—	0.91	0.20
	2,4-D-treated	12.0		15.0		21	9	0.42	1.25	
					Rice					
3rd day	Untreated	8.0	0.31	7.5	1.13	100	—	—	0.94	0.28
	2,4-D-treated	2.5		8.5		31	82	2.65	3.40	
6th day	Untreated	19.5	0.51	18.5	0.81	100	—	—	0.94	0.53
	2,4-D-treated	10.0		15.0		48	33	0.70	1.50	

*† Divisions on Warburg's microrespirometer scale/90 minutes/6 seeds and /60 minutes/10 seeds, respectively.

The low ratios in respiratory intensity between the treated and untreated seeds clearly indicate that the seeds treated with 2,4-D cannot very well utilize oxygen in the air during germination and must find some other recourse, such as fermentation, for energy supply. Hence, during the few days following the chemical treatment, these seeds, in comparison with the control, exhibit a low oxygen uptake and a high carbon dioxide evolution, and, consequently, a high $CO_2:O_2$ ratio. This effect is very similar to that caused by germinating seeds under low oxygen tension, which has been fully described by Taylor (*3*). As a result of O_2 deficiency in the medium, aerobic respiration is reduced, and this reduction is to some extent compensated for by the fermentative activity of the germinating seeds, as evidenced by the high $CO_2:O_2$ ratios under such a condition. If they cannot furnish the energy necessary for germination fermentatively, most seeds will fail to germinate at all. If, as in rice, the seed is especially gifted with a highly functional fermentative mechanism, it can proceed to germinate, although with some delay, even after 2,4-D treatment or under anaerobic condition. However, this condition cannot go on indefinitely. Even rice cannot continue to grow in the complete absence of oxygen.

During recent years evidence has accumulated which shows that auxin is involved in the 4-carbon acid respiratory system (*4*). The increased respiration due to auxin treatment was found to parallel the increase in elongation of, and the acceleration of protoplasmic streaming in, the *Avena* coleoptile. This statement is probably true only at certain low concentrations of auxin.

Our experiments have shown that 2,4-D, at low concentrations (0.01 per cent), promotes germination; but, at higher concentrations (0.1 per cent), it begins to inhibit aerobic respiration and checks germination.

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Prevention of Respiratory Embarrassment in Therapeutic Curarized Convulsions

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Transitory asphyxia and cyanosis occur so frequently in spontaneous and therapeutically induced convulsions that cerebral anoxia was considered a possible explanation for the beneficial effects of convulsions in mental disorders. However, it has been demonstrated that the production of cerebral anoxia by the inhalation of nitrogen has no such therapeutic value (*4*). On the contrary, asphyxia contributes clinically to cardiac strain and plays a role in the fatalities and near-fatalities that occasionally occur in convulsions. The treatment of asphyxia by the use of chemical stimulants has proved futile (*3*). Administration of oxygen is ineffectual unless the air passages are open. The presence of trismus makes the installation of apparatus to clear the respiratory passages *after* a convulsion difficult (*1*) and often impossible. We have found that although administration of the convulsant electric current during inspiration facilitates postconvulsive breathing, since the first respiratory movement is then an expiration which clears the passages, this so increases intrapulmonary and venous pressure as to make the procedure not without risk. This procedure has, therefore, been discarded.

Certain few patients are "hard breathers" in that they persistently have asphyxial episodes during and after convulsive seizures. They seem to fall into two main categories: (1) those whose illness is characterized by agitation, depression, rejection of food and sleep, and other psychological "oral" qualities; and (2) patients with evidence of generalized arteriosclerosis or other neurologic complications, in whom there appears to be some inefficiency in the respiratory apparatus. The physician is sometimes compelled to treat a patient with coronary disease, whose agitation is so marked and dangerous to the heart as to necessitate the administration of shock treatment in an attempt to terminate the mental disorder. It is precisely those patients falling into both categories who are apt to show respiratory difficulties and in whom asphyxia is most dangerous. In these patients it is impossible to soften the convulsion adequately by means of curare because it increases respiratory difficulty and asphyxia. By premedication with sodium pentothal or sodium amytal (*2*) one can increase slightly the dosage of curare. The sedation seems to diminish the preconvulsive anxiety and restlessness and to diminish pharyngeal spasm. Unfortunately, these barbiturates increase the postconvulsive apnea.

We have found a simple means of avoiding asphyxia and consequently diminishing cardiac strain. With this technique a Guedel rubber airway is installed *during* the convulsion.

The patient is prepared as usual for the treatment. He is placed supine on a flat bed without hyperextension, since the latter increases respiratory difficulty. The barbiturate and curare, or curare alone, are injected. In electroshock convulsions, a cloth gag is placed between the teeth to protect the tongue and lips. The current is then applied. During the initial tonic flexion phase, the gag is forcibly bitten. This is followed by a moment of relaxation in which the mouth is opened widely. At this point a Guedel rubber airway is introduced to the hilt. Where metrazol is used, the cloth gag is not necessary. The initial movement of the mouth is an opening one, and the airway is similarly introduced. With the airway in place there may be respiratory exchange in the midst of the convulsion. Before the end of the convulsion, the patient is turned on the side with the mouth down. Mucus and saliva will flow from the airway. Respiration usually begins shortly after the convulsion is over. The airway is removed a few minutes after the convulsion, when respirations are normal and the mouth and jaw relaxed.

With this technique asphyxia and cyanosis are now rare. There are occasional periods of apnea, which seem to be of central origin. In these apneic periods it is a simple matter, with the air passages open, to institute respiration, if one so desires, by abdominal pressure. The airway acts as an efficient mouth gag and bitten tongues and lips are infrequent. A theoretical objection to the method is the possibility of dislocation of the jaw and trauma to the pharynx, but in practice neither occurs. Postconvulsive headache, nausea, and confusion have been diminished considerably. Larger amounts of curare can be administered safely to hard breathers. In one patient with known severe coronary disease, the postconvulsive electrocardiographic changes were less marked and of much shorter duration with this method. Patients who are not sedated are less apt to show postconvulsive restlessness. The postconvulsive hypertension is reduced, but not entirely eliminated. Observations with different methods of therapy indicate that there are at least four factors in postconvulsive hypertension: (1) anxiety and restlessness, which can be alleviated by means of intravenous sodium pentothal or sodium amytal; (2) muscular exertion, which can be alleviated by means of curare; (3) asphyxia, which can be prevented by the method described; and (4) a cardiac convulsant action. The heart seems to take part in the generalized convulsion, cardiac irregularities having been reported during seizures. These are less marked when asphyxia is prevented. Hypertension does not always accompany partial convulsions, but is an invariable component of generalized seizures, although it is less marked and of shorter duration with the technique described. In the postconvulsive period, especially with metrazol, premature cardiac beats coincide with mild, generalized twitches. These coincide too well temporally to be explained except on the basis of a common stimulus. The fact that this hypertension can be temporarily arrested by carotid sinus pressure suggests that there is a nervous pathway through the autonomic nervous system. Clinically, however, with the prevention of asphyxia, anxiety, restlessness, and severe muscular exertion by means of the technique outlined (barbiturate, curare, intraconvulsive airway) most cardiac patients seem able to stand the convulsion with minimal evidence of cardiac strain.

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Photoinactivation of Milk Fat Lipase and the Origin of Bitter Flavor in Milk

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H. D. Kay recently reported in a letter to the editor of *Nature* (*2*) that an enzyme which hydrolyzes tributyrin in milk (tributyrinase) is sensitive to light and that the atmospheric oxygen plays an important part in the photodestruction of the enzyme. This letter prompts the present writer to release information pertaining to the mechanism of the photochemical inactivation of milk fat lipase and to the origin of bitter flavor in milk, obtained in connection with studies of the interrelationship of ascorbic acid oxidation in milk and the reaction which produces the tallowy flavor (*4*). It has been found that the activity of milk fat lipase, as produced by cooling, warming, and the subsequent holding of milk at 0–5° C. from 24 to 48 hours (*5*), varied with the ascorbic acid content of the milk reduced to various levels by exposure to light (Fig. 1B). The phenomenon suggested the possibility that H_2O_2, formed in the course of the photooxidation of ascorbic acid (*1*), might be responsible for the inactivation of milk fat lipase.

This postulation made it necessary to determine the effect of H_2O_2, added to milk in different quantities but not in excess of that required to oxidize the ascorbic acid completely, upon the activity of milk fat lipase. The results were that both processes, namely, the oxidation of ascorbic acid and the destruction of lipase, were promoted simultaneously in the milk (Fig. 1A).

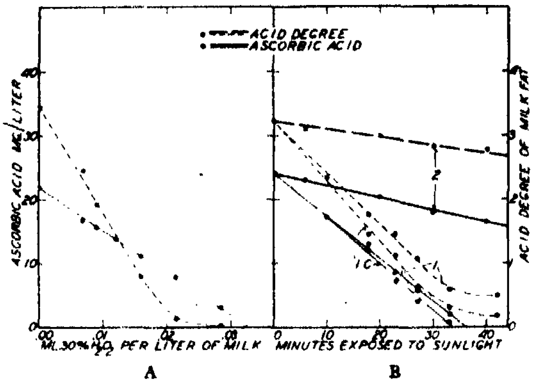

Fig. 1. Simultaneous promotion of ascorbic acid oxidation and of inactivation of milk fat enzyme lipase in the milk either in the presence of added H_2O_2 or photochemically by the exposure of milk in Erlenmeyer flasks to direct sunlight (B, 1) or northern daylight (B, 2). Sample 1 C was exposed in the presence of added catalase. Lipolysis was activated by cooling-warming-recooling of milk, and activity measured by increase in the acid degrees of fat at the end of a 48-hour holding period at 0–5°C. Ascorbic acid content of the milk was followed by direct titration with 2,6-dichlorophenol-indophenol in acid solution.

Consequently, to prove that the photooxidation of milk fat lipase resulted from H_2O_2 formed in the course of ascorbic acid oxidation, a portion of lipolytically active milk was fortified with catalase prior to exposure to sunlight. The amount of catalase (*6*) added to milk was sufficient to prevent ascorbic acid oxidation in the presence of 0.028–0.03 ml. of 30 per cent H_2O_2 solution/l. of milk, added subsequently. The activity of catalase, determined again at the end of 40 minutes of exposure to sunlight by the addition of ascorbic acid to milk depleted of its content and of H_2O_2, was found to be the same as at the starting point. The photoinactivation of milk fat lipase was not prevented, however, by the addition of catalase to milk (Fig. 1B). In fact, the enzyme was inactivated at a slightly faster rate in the presence of catalase as compared with that in the control milk. It was apparent, therefore, that the photoinactivation of lipase is an independent reaction, and that H_2O_2 formed in the course of ascorbic acid oxidation might play an auxiliary part. This evidence was supported further by data concerning the effect of the depletion of the ascorbic acid content of milk, prior to exposure to light, by cucumber juice oxidase. Since the ascorbic acid–cucumber juice oxidase system uses one atom of oxygen per molecule of vitamin C (*1*), it was safe to assume that no H_2O_2 was present in the milk at the time of exposure. Again, the sensitivity to light of the milk-fat-splitting enzyme was found to be approximately the same as in the control portion of milk containing ascorbic acid. It was also found that sensitivity of milk lipase to light varied appreciably between the samples of milk from different cows and that, of the 20 samples studied, only two samples showed from 80 to 90 per cent loss in the lipolytic activity due to 30 minutes' exposure to light. The losses of lipase in the remaining samples of milk varied from 50 to 80 per cent. The inactivation of milk lipase by added H_2O_2 was considerably reduced in the presence of catalase, whereas deoxygenated milk sealed under vacuum showed an increase in lipolytic activity over that in control milk. The continuous exposure to sunlight up to 90 minutes reduced its activity approximately 10 per cent. Fat lipolysis in milk is quite often accompanied by the development of bitter flavor, which can be traced primarily to the gravity cream layer of the milk. This could be demonstrated by draining off carefully the gravity skim milk below the cream layer of milk at the end of a 24-hour holding period at 0–5° C., in which lipolysis was stimulated by cooling and warming prior to storage. It indicated that the changes in the chemical properties both of the fat and of the fat-globules-stabilizing membrane could be responsible for the development of the bitter flavor. Not only has the milk-fat-agglutinin concentrate (gravity cream plasma, obtained by the reseparation of gravity cream forewarmed to 37–40° C. in the cream separator, *3*) a tendency to develop bitter flavor on standing at refrigeration temperatures, but the milk fat from very rancid milk is quite often bitter. The compound responsible for the bitter flavor in the fat could be readily extracted by the re-emulsification of the fat in the skim milk.

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The Origin and Evolution of Meiosis[1]

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The question of the relation of mitosis to meiosis has received as much attention, perhaps, as any in biology. The discussion has been focused, for the most part, on the mechanism responsible for the change from one type of nuclear division to the other, and the manner in which meiosis, which made sex and biparental inheritance possible, originated. Certainly, one difficulty in tracing the origin and development of meiosis from mitosis has been the failure to understand clearly the small but fundamental differences in the two processes. And, of course, the assumption by some biologists that the two processes were almost unrelated has not helped toward an understanding of them. Far too little attention has been given to the role of the centriole and the relation, in time, of its duplication to that of the chromosomes, for herein lies the key to an understanding of the manner in which a cell changes from one process to the other.

For many years I have been studying the chromosomes of 40 genera and more than 500 species of hypermastigote and polymastigote flagellates from termites and the wood-feeding roach, *Cryptocercus punctulatus* (*1*). The protozoa of *Cryptocercus* are profoundly influenced by the molting of their host (*2*). Between molts they have the haploid number of chromosomes, and division is mitotic; during molting their chromosome number is doubled, and zygotic meiosis, which follows, returns them to haploids, where they remain until their host molts again. In three genera, *Trichonympha*, *Leptospironympha*, and *Eucomonympha*, the change from haploidy to diploidy is brought about by fertilization; in others, particularly *Saccinobaculus*, it results from the autogamy. In these genera sexual processes similar to those of higher animals and plants have become fairly well established, but not permanently, for sometimes they revert to a more primitive process, such as the one that has become very well established in *Barbulanympha* and several other genera, which process will be described presently.

Of the total number of genera studied there are six which, in my opinion, are particularly important, since they serve to show the manner in which meiosis has arisen from mitosis. Among these, two processes, permanent mitotic diploidy and meiosis without gametogenesis, deserve consideration. They lie between fertilization (including autogamy) on the one hand, and mitosis on the other.

In the first process, which is seen in the genera *Holomastigotoides* and *Spirotrichosoma*, the chromosomes, in certain instances, have become permanently diploid, since these genera have not been able to develop a method for changing back to haploids. In the genus *Holomastigotoides*, which is present in many genera of termites distributed through most of the tropical and semitropical regions of the earth, the haploid number of chromosomes is 2, and most of the species have this number. However, in each of the species of termites that I have examined from the genera *Prorhinotermes*, *Psammotermes*, *Coptotermes*, and *Heterotermes*, diploids have also been present, together with a 3-chromosome form (1n, 2n); and, in *Psammotermes*, there is in addition a 5-chromosome form (2n, 3n). All of these are derived from the basic 2-chromosome form. This polyploidy is not one of recent origin, since, for example, precisely the same forms occur in widely separated species of *Prorhinotermes* (southern Florida, Java, Madagascar), which termites have been separated at least since the beginning of the Tertiary, and probably much longer. *Holomastigotoides*, then, in a few instances, has been able to survive in a permanent diploid condition.

Another example of a similar situation is found in the genus *Spirotrichosoma*, present in three species of *Stolotermes* (a very primitive termite) from Australia, one from South Africa, and one from New Zealand. The haploid number of chromosomes is 12—the number present in all the species of *Spirotrichosoma* from the Australian and South African species of *Stolotermes*. This same number also occurs in the *Spirotrichosoma* from the New Zealand species of *Stolotermes*, but polyploids with 24, 48, and 60 chromosomes are also present. Thus, with a larger number of chromosomes, the difficulty an organism encounters in permanently adapting itself to polyploidy seems to be greatly increased.

Nuclear division of these polyploids can be seen very plainly, especially those with 4 rod-shaped chromosomes. Every division is exactly alike: synapsis in the prophase, followed by formation of tetrads, and movement of the chromosomes to the poles as dyads, *i.e.* every division is exactly like the first division in meiosis. One may ask: Why isn't this followed by a second meiotic division, thus returning the chromosomes to the haploid condition? The answer is simple: the centrioles are

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[1] Aided by a grant from the Milton Fund.

not duplicated until the chromosomes have also been duplicated, and therefore reduction in chromosome number is impossible. Then, so long as the chromosomes are duplicated every time the centrioles are, diploidy is permanent. The schedule of centriole-chromosome duplication must be changed before reduction can occur.

In the second process, which is termed endomitosis, meiosis occurs, but it is neither preceded nor followed by nuclear fusion. Several genera are involved, not all of which behave in the same manner, but nearly enough so, perhaps, that only one, *Barbulanympha*, need be mentioned. This is an unusually large cell with two interphase centrioles 40–50 μ long and 3–4 μ in width, with centrosomes 5–6 μ in diameter surrounding their distal ends. It is from these ends of the centrioles that the achromatic figure is produced, while the other, or proximal, ends produce new centrioles directly and other extranuclear organelles (flagella, axostyles, and parabasals) indirectly. As a result of molting, these centrioles degenerate and, because of their size, the process may be observed step by step; but before they degenerate each produces a small, new one from its proximal end, just as in each mitotic division. Shortly after the old, or parent, centrioles degenerate, parabasals, axostyles, and flagella begin to do so, the last to disappear being the flagella. Before degeneration of these organelles has progressed very far, two small, new, intracytoplasmic, flagellated areas, produced by the new centrioles, make their appearance adjacent to the nucleus, which at this time lies more or less in the center of the cell, having migrated there together with the new centrioles. There is one new, short centriole underneath each area, and as these become longer and larger, so do the flagellated areas, until finally both are fully grown. Shortly before growth of the flagellated areas is completed, new sets of parabasals and axostyles begin to grow out from their inner margins. Thus, two complete sets of extranuclear organelles arise from the new centrioles and replace the two degenerated sets. The flagella, which are motile throughout their growth period, remain in the cytoplasm until a few hours after the roach sheds its exoskeleton and then are extroverted.

About the time the new flagellated areas begin to develop there is a duplication of the chromosomes, but, since the short, new centrioles, the only ones now present, cannot produce an achromatic figure to move the chromosomes to separate poles, they remain in a single, undivided nucleus, in which they go through all the phases of mitosis. About two days after the new centrioles attain full size, they begin to produce an achromatic figure from their distal ends and, shortly before this takes place, the chromosomes are duplicated again, so that now each chromosome is represented four times. As prophase shortening occurs, synapsis begins, and soon the plainest tetrads I have ever seen are formed. This is followed by the first meiotic division, the chromosomes going to the poles as dyads. Then the centrioles are duplicated quickly and produce an achromatic figure which functions in the second meiotic division, before duplication of the chromosomes can occur, the chromosomes, of course, going to the poles singly.

Ordinarily, in mitosis in *Barbulanympha* it is at late telophase, frequently after cytoplasmic division, before the new centriole begins to elongate by the side of the old or persisting one; but by the first meiotic metaphase growth has already begun, and by late anaphase or early telophase it is almost complete. It is very easy, then, to see in *Barbulanympha*, where the centrioles are so large, that the mechanism which makes the reduction in chromosome number possible is the speeded-up duplication and function of the centrioles without duplication of the chromosomes. In other words, the centrioles are duplicated between the first and second meiotic divisions while the chromosomes are not, and in this manner the centrioles make up for the generation which was lost earlier (due to degeneration). In the first meiotic division the centrioles are somewhat ahead of the chromosomes and produce an achromatic figure which is ready to function before the relational coiling of the chromatids has time to come out, and poleward movement as dyads results.

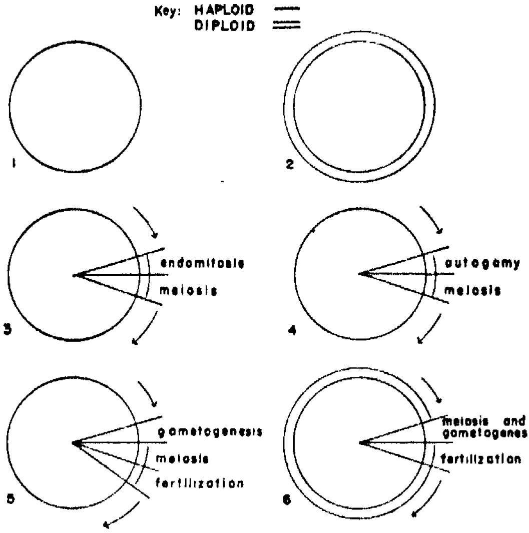

FIG. 1. Progressive stages in the origin and evolution of meiosis. (Each circle represents a life cycle.)

It should be noted that *Barbulanympha* usually behaves in the manner just described, but sometimes the old centrioles produce an achromatic figure before they degenerate. When this happens, nuclear division occurs. The daughter nuclei fuse, and, so far as chromosomes are concerned, the end result is the same as if the nucleus had not divided. This process, termed autogamy, is the usual one in *Urinympha*, although chromosomal duplication without nuclear division also occurs. In these, and other genera too, the type of behavior depends on when a generation of centrioles is lost: if early, duplication of chromosomes without nuclear division results; if late, nuclear division occurs.

The endomitosis of *Barbulanympha* and other genera is closely related to that in several types of cells in insects, reaching its highest development in the multiple, giant chromosomes of the salivary glands of the Diptera. However, insects have developed no workable method of relieving the polyploidy and, because of the instability imposed by such a condition, these cells degenerate, while in *Barbulanympha* polyploidy is always relieved by meiosis, and no degeneration results. Since endomitosis in these protozoa is brought on by the molting fluid of their insect host, similar secretions may be responsible for the production of endomitosis in the tissues of the insects themselves, resulting eventually in degeneration followed by reorganization (metamorphosis).

In gametic meiosis, which precedes fertilization, and in zygotic meiosis, which follows fertilization, centrioles are duplicated without a corresponding duplication of the chromosomes, and this extra generation makes up for the one lost at fertilization by one of the gametes (each gamete has two centrioles). Briefly, then, in changing from mitosis to meiosis, the centrioles gain a generation on the chromosomes, and in changing back to mitosis, they lose a generation, although ultimately there are the same number of generations of both.

We see in *Barbulanympha* and *Holomastigotoides* the changes which occurred in the transition from mitosis to meiosis, resulting finally in the formation of gametes. The first step is diploidy, and anything which prevents the centrioles from producing an achromatic figure or the achromatic figure from functioning properly in the movement of chromosomes can bring about a change from haploidy to diploidy. This is as far as *Holomastigotoides* and *Spirotrichosoma* have been able to go. *Barbulanympha* has gone one step beyond these organisms; by throwing the centriole-chromosome duplication schedule out of line, it has evolved a method for changing from haploidy to diploidy and vice versa. The next step is seen in *Saccinobaculus* and *Urinympha*, and sometimes in *Barbulanympha*, where the loss of a generation of centrioles does not usually occur until after the nucleus divides (otherwise the nucleus would not divide). Cytoplasmic division does not occur, the nuclei fuse, the chromosomes are duplicated, and two meiotic divisions change them to haploids. The next and final step occurs in *Trichonympha* and two other genera. The advance is a small but very important one: the cytoplasm divides and thus produces gametes which are free to fuse in any manner.

Evolution of meiosis has been direct: *Holomastigotoides*, haploidy to diploidy; *Barbulanympha*, diploidy to haploidy and vice versa; *Saccinobaculus*, fusion of nuclei; *Trichonympha*, cytoplasmic division producing gametes. In each stage after the first one, the events of the preceding stage are repeated, and one additional step forward is taken. *Trichonympha*, for example, goes through all the stages that the other organisms do and, in addition, produces gametes.

If meiosis, as many observations indicate, serves to relieve the instability of polyploidy—the relief when it is zygotic usually being for a longer period than when it is gametic—one might almost say that biparental inheritance and all the evolution that it has produced resulted because of the particular method which most organisms developed to free themselves from the limitations of permanent polyploidy.

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Are Lake Salmon Hereditarily Distinct?

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Peculiar salmon found in certain lakes of Europe and eastern North America have been considered by taxonomists to be distinct species (e.g. *Salmo sebago, 1*), merely subspecies (e.g. *Salmo salar sebago* and *S. s. ouananiche, 3*), or varieties (e.g. *S. s.* var. *lacustris, 2*) of the ordinary sea salmon.

Similar, supposedly nonmigratory kinds have been found in various other species of *Salmonidae*. Without proof, there should not be unquestioning acceptance of these as being hereditarily distinct kinds rather than the effects of environment on the individuals. The utter lack of published data from experiments to distinguish the effects of heredity and environment and the difficulty of carrying out such experiments should make the following of interest.

At Grand (Shubenacadie) Lake, Nova Scotia, the young from the lake salmon, locally known as "grayling," are reared for planting to get "grayling," and the young of sea-running salmon from the River Philip of northern Nova Scotia are reared for planting to get sea salmon. Grand Lake discharges into Shubenacadie River, which contains sea-running salmon. These evidently spawn in tributaries (entering the river below Grand Lake) which drain a relatively lakeless and arable country in comparison with the rocky country, well provided with lakes, that forms the watershed of Grand Lake. There is no physical barrier to prevent the young of these "grayling" from descending to the sea or the sea salmon from ascending into the lakes, which they may do. Are the differences in appearance, structure, and migration between "grayling" and sea salmon the results of a difference in heredity, which would justify keeping the stocks separate, or are they the results of differences in the conditions they face as they grow up?

In June of both 1944 and 1945, yearling offspring of lake and sea salmon, as reared at Grand Lake, were marked distinctively and planted together in equal numbers in streams in a linear series draining into Grand Lake. This has been a cooperative experiment by the Fisheries Research Board of Canada and the Fish Culture Branch of the Department of Fisheries. Supt. W. H. Cameron reared the salmon and marked them, the "lake" salmon by removal of the adipose and right pelvic, and the "sea" salmon by removal of the adipose and left pelvic fins. The streams planted formed, with intervening lakes all tenanted by lake salmon, an ascending linear series: Grand Lake, lower Rawdon River (½ mile long), Long (Kinsac) Lake, upper Rawdon River (⅓ mile long), Beaverbank Lake, and Beaver River (1-mile stretch).

Very few survivors were found in September seinings, either from the 9,538 marked yearlings planted in 1944 or from the 9,240 planted in 1945. Although the streams had scarcely any bottom suitable for spawning, native parr of comparable size (yearlings or older) were present and finally predominated over the marked fish, as if they kept possession of the good places in the streams by virtue of being there first. So far as could be judged by September seining, the few parr were in both years mainly in the lower part of Beaver River, but the numbers taken were very small: 1944—9 native, 1 "sea," 1 "lake"; 1945—16 native, 1 "sea," 1 "lake." With higher water they were more numerous in 1945 than in 1944 (more taken with less seining), which afforded a better opportunity to follow their movements.

That they may have descended into the lakes shortly after planting and survived there seems negatived by the facts that (1) five lots of 50 yearlings each when planted in 1945 above traps in branches of the Petitcodiac River, N.B., failed during that season to appear in the traps or to be seined more than 200 yards from the point of planting, and (2) 175 yearlings planted in 1946 above a trap on the lower Rawdon River failed to appear in the trap and yet disappeared utterly so far as seining showed.

With so few survivors even in the first few months of stream life, the only good chance for determining any difference in migratory behavior seemed to be to trap the fish when descending as smolts the next spring. Only one trap was feasible, and this was placed on the lower Rawdon River near the lower limit of planting. If neither kind migrates seaward through Grand Lake, a trap at its outlet will get no smolts—a fact which might be interpreted as failure of any "sea" salmon to survive. If "lake" smolts, in descending, stop in the first lake they reach, but "sea" smolts continue seaward, a trap in the lower Rawdon will take "lake" smolts only from lower Rawdon but upper Rawdon and Beaver as well as lower Rawdon "sea" smolts. With such a difference in migratory behavior, it was expected that more "sea" than "lake" smolts would be trapped.

D. I. Rice, of Dalhousie University, Halifax, constructed the trap and operated it from May 26 to July 31, 1946. No salmon descended after June 12 by which time 105 native, 2 "lake," and 2 "sea" smolts had entered the trap. There was, therefore, failure to find any difference in migratory behavior. Further experiments are desirable to discover possible hereditary differences in migratory behavior of supposed "races" or "strains" in salmonid species.

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Role of Glucose in Promoting Growth of *Lactobacilli* in Saliva

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It has been shown that an oral strain of *Lactobacillus* grows and produces acid to a maximal extent when incubated on a synthetic medium consisting of d-glucose, tryptophane, sodium acetate, potassium phosphates, thiamine hydrochloride, calcium pantothenate, nicotinic acid, and casein hydrolyzate (vitamin free) (*4*). In a subsequent report (*2*) it was shown that whole saliva could substitute only partially for the three water-soluble vitamins, but completely substituted for the mineral salt fraction of the synthetic media. However, the whole saliva did not serve as a substitute for either casein hydrolyzate or tryptophane. In a later paper (*3*) saliva hydrolyzed by acid or alkali was found capable of substituting for casein hydrolyzate in the synthetic media. It was also found that it was unnecessary to add l-tryptophane to the media when an alkali hydrolyzate of saliva was substituted. These observations suggested saliva as a potential source of the amino acids found essential for the growth of an oral strain of *Lactobacillus*.

The present report is concerned with (a) observations on some chemical changes occurring in saliva incubated with glucose at body temperature, and (b) the use of an incubated saliva-glucose mixture as a substitute for tryptophane and for casein hydrolyzate in a synthetic medium. For these purposes whole saliva, collected from individuals, was incubated at 37.5°C. with and without glucose. To estimate the proteolysis occurring in incubating saliva the "carboxyl CO_2"[1] changes were determined. The ammonia (plus urea) nitrogen changes were also measured as an index of deamination.

As a result of the addition of glucose to incubating saliva there was an increase of approximately 100 per cent in the "carboxyl CO_2" liberated during the incubation. Also, markedly less ammonia was formed in the saliva incubated with glucose. These results are interpreted as evidence that the presence of glucose in saliva favors proteolysis over deamination. Table 1 illustrates the findings in a typical experiment. Further observations have been made regarding the ability of saliva, given preliminary incubation in the presence of glucose, to substitute for tryptophane and to a lesser extent for the casein hydrolyzate in synthetic media. Typical findings are shown in Table 2.

TABLE 1

Changes in "Carboxyl CO_2" and in Ammonia (Plus Urea) Nitrogen of Incubating Saliva With and Without Added Glucose

Period of incubation (hrs.)	"Carboxyl CO_2" present (mg. %)	Ammonia (plus urea) nitrogen (mg. %)	pH
No glucose present			
0	1.52	20.9	8.25
120	0.42	45.9	7.47
1% glucose added			
0	1.52	20.9	8.25
120	4.07	22.6	3.68

TABLE 2

Acid Produced in Basic Medium in Which Saliva Incubated for 192 Hours Was Substituted for Certain Essential Growth Factors

Replacement	Essential substance omitted from media	Acid produced (ml.)
Saliva incubated without glucose	Casein hydrolyzate	0.06
Saliva incubated with glucose	Casein hydrolyzate	1.05
Saliva incubated without glucose	Tryptophane	0.18
Saliva incubated with glucose	Tryptophane	5.00

These chemical findings suggest an additional role for glucose in the physiology of the oral cavity. In contact with saliva at body temperature, glucose assists in the liberation of amino acids which can be utilized as nutrients for the growth of oral *Lactobacilli*. The data obtained in this investigation will be published in detail at a later date.

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[1] Terminology of Van Slyke, Dillon, MacFadyen, and Hamilton (*1*).

High-Frequency Dielectric Heating in Heterogeneous Catalysis

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High-frequency dielectric heating of materials is rapidly becoming a common practice in the plastics, wood, cellulose, and other industries (*1*). There are many advantages in this method of heating materials to a desired temperature. Since the dielectric heating arises within the material, due to rotational motion of molecules or translational oscillation of ions, the material is heated uniformly from the inside, and the factors of heat transfer are not involved. High-frequency dielectric heating is characterized by (1) speed of attaining a desired temperature, (2) uniformity of heating, and (3) absence of heat transfer from without.

These features make it very attractive for application in heterogeneous catalytic reactions. The uniformity of heating will eliminate the local overheating in spots of the catalyst and consequently minimize undesirable side reactions, increase the life of the catalyst, and produce a more uniform product. The rapidity of attaining the desired temperatures might decrease the over-all processing time, increase the space velocity, and decrease the size of the catalytic chamber.

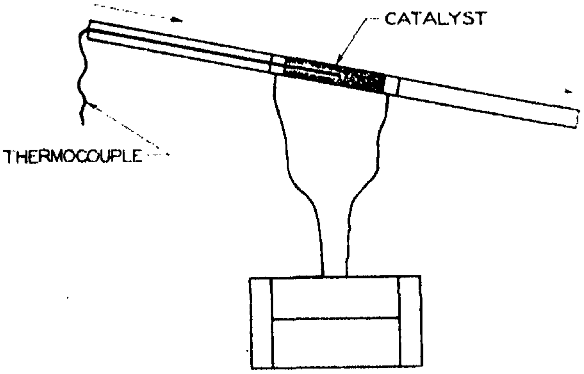

Fig. 1.

These last features could have particular advantage for catalytic processes using a so-called "fluidizing" technique such as fluid catalytic cracking of petroleum. Naturally, only such solid catalysts as are dielectric by nature can be heated by high-frequency electric field.

In the following experiments, conducted in our laboratory, two reactions were carried out using dielectric catalysts: (1) dehydration of ethyl alcohol over alumina, and (2) dehydrocyclization of heptane to toluene over chromia-alumina.

The apparatus[1] consisted of a pyrex glass tube, with an inside diameter of 20 mm., filled with catalyst. The catalyst bed was 20 cm. long. Two brass electrodes were placed on both ends of the catalytic bed, outside the glass tube and connected to a Westinghouse radio frequency generator (1-KW unit).

After establishing a desired temperature (measured by a thermocouple placed in the center of the catalyst bed), which took from 3 to 5 minutes, the materials were introduced and the products recovered and analyzed in the usual way. The arrangement is shown in Fig. 1. The reactions proceeded with excellent results, giving a 90 per cent yield in the case of dehydration (at 350° and space velocity of 0.5) and 75 per cent yield for dehydrocyclization (at 500° and space velocity of 0.5).

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Method for Differential Staining of Mycorrhizal Roots

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In connection with an investigation of the cause of a foliar decline disease of southern pines (*2*), a study was made of the anatomical features of mycorrhizal roots formed on shortleaf pine (*Pinus echinata* Mill.). Several techniques have been used for the differential staining of hyphae of the Hymenomycetes, which form the mantle and Hartig net of ectotrophic mycorrhizae. Cotton blue in lactophenol is fairly specific for the hyphae provided counterstaining is not desired. Young (*6*) also obtained satisfactory results with cotton blue. McArdle (*3*) used the following differential methods: (1) hematoxylin with safranine, and (2) Pianeze III. In a study of the mycorrhizae of Colorado flora, Thomas (*5*) used a combination of safranine and fast green. A modification of the orseillein BB procedure described by Strasburger (*4*) has been used for staining mycorrhizae. (It should be mentioned that orseillein is not the same as orcein.) The procedure is as follows: Stain for 10 hours in a saturated solution of orseillein BB in 3 per cent acetic acid and counterstain with crystal violet in clove oil. All of the above techniques failed to contrast clearly the mantle and Hartig net with the cortical elements of the short roots.

Experimental tests demonstrated that a modification of Cartwright's (*1*) picroaniline blue procedure is superior to the above techniques for the differential staining of mycorrhizal roots. In the procedure which has been adopted for histologic studies of all types of such roots, the roots are fixed for at least 48 hours in a solution of 1.5 ml. of acetic acid, 8.5 ml. of formaldehyde, and 90 ml. of 50 per cent ethyl alcohol. Zirkle's (7) N-butyl alcohol procedure is used for imbedding in paraffin, and Land's gum arabic-potassium dichromate procedure, for attaching ribbons to the slides. The slides are (1) stained for approximately 30 minutes with dilute safranine prepared by adding 3 ml. of a 0.5 per cent solution of aqueous safranine to 70 ml. of water in a Coplin jar, (2) rinsed in water to remove excess stain, (3) stained for 5–10 minutes in a solution prepared by adding 3 ml. of Cartwright's picroaniline blue to 70 ml. of water in a Coplin jar, (4) rinsed again in water to remove excess stain, (5) dehydrated by carrying the slides through a series of alcohol dilutions to 95 per cent alcohol, (6) cleared in Diaphane solvent, and finally (7) mounted in Diaphane.

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[1] The author wishes to thank Dr. W. F. Winget for valuable help in operating the high-frequency unit.

By this procedure the blue-staining hyphae of the Hymenomycetes associated with ectotrophic mycorrhizae are clearly contrasted with the red-staining elements of the short roots The dark-colored hyphae of the pseudomycorrhizal fungi are not stained. Differentiation of the intracellular hyphae, which grow out from the Hartig net, was obtained by using Wratten filter B (No. 58) in the microscope lamp.

The results obtained by the use of the above technique suggest the possibility that the foliar decline diseases of pine may be related to a reversal of symbiosis, which causes the mycorrhizal fungi to become parasitic on the short roots when soil conditions become unfavorable.

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A Blood Test for Estimating the Week of Pregnancy[1]

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In a recent report (*1*) it was shown that the ability of human pregnancy plasma to inactivate pitocin increased over a thousandfold from the time of conception until term, and it was suggested that such a measurement might be useful in determining the week of pregnancy. The enzyme to which we refer as pitocinase is probably a peptidase and has not yet been fully characterized. In the present investigation it is shown that the concentration of this enzyme in the blood increases in a linear fashion for the first 16 weeks after conception, and that it is only during this period that the quantitative determination is reasonably accurate. Fortunately, it is during the first half of pregnancy that such information is usually desired, for beyond that time the activity, size, and osseous development of the baby are reasonably good criteria. The present report describes in detail the methods employed and the interpretation of the results.

Method

Plasma from fresh, nonhemolyzed, oxalated blood, commercial pitocin, and saline are incubated at 37° C., and samples are removed at various times for assay of the residual pitocin. The plasma concentration and incubation times vary, of course, with the approximate duration of pregnancy. These are shown in Table 1. If the approximate duration is not known, more than one determination must be made. Immediately after mixing, one-quarter of the sample is withdrawn and diluted to 12.5 ml. with 0.85 per cent saline. One drop of 2 N acetic acid is added to bring the pH to about 5.5 (with chlorophenol red as an indicator), and the tube is placed in a boiling-water bath for 5 minutes. The sample is then filtered and neutralized (using bromthymol blue) with 1 drop of 2 N sodium hydroxide. This is the "zero time 100 per cent pitocin sample" with which the others are compared. The remaining portions, exactly equal in volume to the first, are withdrawn at the indicated times and treated in an identical manner. When incubations are prolonged for more than two hours, it is essential to incubate *in vacuo* in modified Thunberg tubes containing a few drops of toluene in order to prevent loss of enzyme activity through oxidation or bacterial action. Incubations of 24 hours are likely to give lower values because of shifting temperature optima.

TABLE 1

Wks. after conception	Range of units/ml. plasma	Incubation mixture (ml.)			Incubation times*	k′
		Pitocin	Plasma	Saline		
3–4	0.06–0.1	0.5	5.0	0	0, 18, 24 hrs.*	76
5–6	0.16–0.2	"	"	9.5	0, 18, 24 hrs.*	208
7–9	0.33–0.66	"	"	0	0, 1, 3, 5 hrs.*	76
10–12	1.0 –2.3	"	"	0	0, 20, 45, 90 min.	76
13–15	3.3 –6.0	"	"	4.5	0, 15, 30, 50 min.	139
16–18	10– 18	"	"	19.5	0, 15, 30, 45 min.	346
19–21	20– 30	"	"	Dilute to 50 ml.	"	693
22–24	35– 45	"	3.33		"	1,039
25–27	50– 65	"	2.0		"	1,732
28–30	60– 85	"	1.67		"	2,079
31–38	80–110	"	1.25		"	2,772

* When time exceeds 90 minutes, incubate anaerobically with toluene.

The relative amount of pitocin in each filtrate is then estimated by a standard U. S. P. oxytocic assay, using the isolated uterus of a rat or guinea pig. While details of the bio-assay cannot be presented in this brief communication, the technics and computations are well standardized (*2*). Obviously, the accuracy of the test hinges upon the care with which the bio-assay is made.

Using a sheet of semilog paper, the percentage of pitocin remaining in each sample is plotted (on the log scale) against time (on the arithmetic scale). Starting with 0 time and 100 per cent pitocin, a straight line is best fitted through the remaining points in order to obtain the average velocity of the reaction. The time in minutes where this line crosses the 50 per cent mark is called $t_{\frac{1}{2}}$, or the time for half destruction.

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[1] Supported by grants from the John and Mary Markle Foundation and he James Fund.

The value k′ (see Table 1) divided by the $t_{\frac{1}{2}}$ then gives the number of pitocinase units/ml. of plasma.

The value k′ is derived from the formula for a first-order reaction and takes into account the plasma dilution. In the formula, $k = \frac{1}{t} \times \log_e \frac{C_o}{C_t}$, k represents the velocity, C_o the concentration of the substrate (pitocin) at 0 time, and C_t the concentration of pitocin at the time the sample is removed. When $t = t_{\frac{1}{2}}$, the fraction $\frac{C_o}{C_t}$ always equals 2, and the equation may be written: $k = \frac{0.693}{t_{\frac{1}{2}}}$. We have defined one unit of pitocinase activity as 100 × k at 37° C., since in this instance the concentration of enzyme is proportional to the velocity of the reaction. The number of units of pitocinase/ml. of plasma therefore equals $\frac{69.3}{t_{\frac{1}{2}}}$ × the plasma dilution. The value k′ is simply the plasma dilution × 69.3.

RESULTS

Plasma pitocinase determinations were made on 22 normal nonpregnant women, and the mean value was 0.023 units ± S.E. 0.0024, with a standard deviation of 0.011. Curiously enough, this value fluctuates in the normal menstrual cycle, becoming 0.018 during the two weeks centering about the onset of the menstrual period and 0.044 during the two weeks centering about the time of ovulation. The highest value found, 0.06 units/ml., is indicated by Line 0 in Fig. 1 and may be compared with the mean level for women, represented by Line M.

Determinations on 24 normal men gave a mean value of 0.01 ± 0.0014, S.D. = 0.007. This is significantly lower than the value for women, since the difference between the means is 4.8 times the standard error of the difference between the means. It was noted that in four men taking 5 mg. of stilbestrol daily (for carcinoma of the prostate), the mean value was 0.04, or about the level of ovulating women. The presence of jaundice likewise produces an elevated level. It is not known whether these low and fluctuating proteolytic activities are due to the same peptidase found in pregnancy or to some protease which may have some slight inactivating effect upon pitocin.

During the first 16 weeks of normal pregnancy, 37 determinations were made (Fig. 1). Eighteen of these were made on four individuals in order to establish the basic curve, and the remainder are unselected cases, excluding only those with abnormalities of pregnancy such as hydatid moles ectopic pregnancies, and threatened or incomplete abortions—all of which are usually associated with lower values. When the pitocinase values are plotted on a logarithmic scale, they fall on a straight line with a standard deviation of ± 5 days. In each instance, conception was assumed to have occurred two weeks before the expected onset of the first missed period. During the latter half of pregnancy, the curve begins to flatten, and the scatter is greater. When pre-eclampsia supervenes, abnormal values are almost always noted (*1*).

The slope of the line illustrated may be represented by the expression 6 (log y + 1.7). Up to 16 weeks after conception, therefore, we may say that the week of pregnancy is equal to 6 × ($\log_{10}$ of the plasma pitocinase + 1.7) ± a standard deviation of 0.7 weeks.

It may be seen that values above 0.07 units/ml. of plasma, corresponding to four weeks after conception, are diagnostic of pregnancy in women who are not jaundiced. There is no known pregnancy test which may be considered accurate prior to the fourth week. Despite its economy, this method, when used as a purely qualitative indication of pregnancy, requires more time and skill in its present form than a Friedman or Aschheim-Zondek test. The present data suggest that the test measures the product of placental volume and some type of specific activity, and that the latter factor is relatively constant when pregnancy is normal. The method may find usefulness, therefore, when quantitative information is desired.

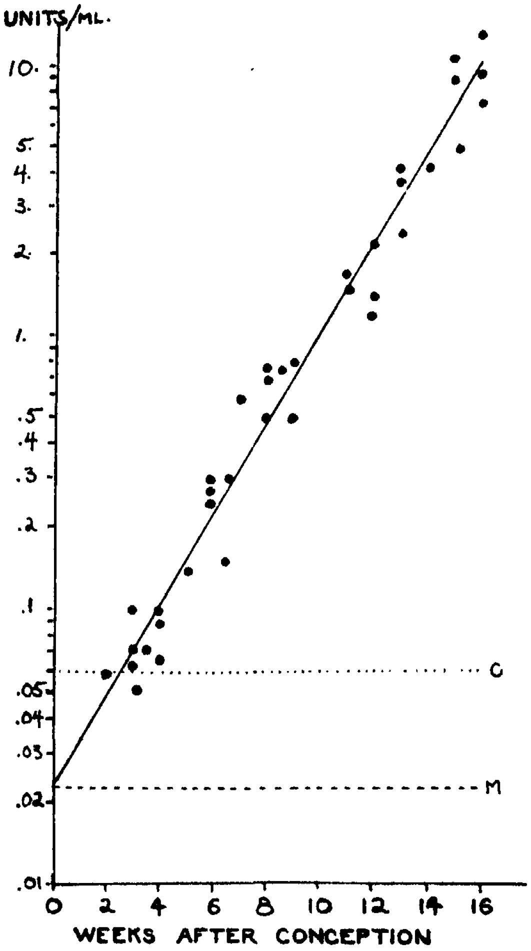

FIG. 1. Relation of plasma pitocinase concentration to the week of pregnancy. Ordinate represents the enzyme concentration in units/ml. plasma; Line M, the mean for nonpregnant women regardless of the phase of the menstrual cycle; Line O, highest level detected at the time of ovulation.

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A Moist Chamber for Nerve-Muscle Experiments[1]

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Frederick Stearns & Company (Division of Sterling Drug, Inc.), Detroit

The moist chamber herein described was developed in order to save the student time in performing routine laboratory experiments involving the use of the nerve-muscle preparation. The standard moist chamber in use in most laboratories is rather cumbersome and requires considerable wiring prior to starting an experiment. If two muscles are used simultaneously in the chamber or if more than one pair of electrodes are used, the actual setting up is indeed time consuming.

This moist chamber (Fig. 1) weighs only 3¼ ounces, is 1⅝ inch deep, 2⅛ inches wide, and 3⅛ inches high. It is made of 1/16-inch lucite. The femur clamps and aluminum electrodes are mounted near the top of the back panel, which is ⅛ inch thick. The two pairs of electrodes are arranged 3 cm. apart, to the left and slightly below the femur clamp. Between these pairs is mounted a shelf of lucite so arranged that the nerve can be placed on it perfectly flat, thus forming a straight line for 3 cm. This group of electrodes is advantageous for experiments in which the student can determine roughly the speed of impulse conduction through the sciatic nerve.

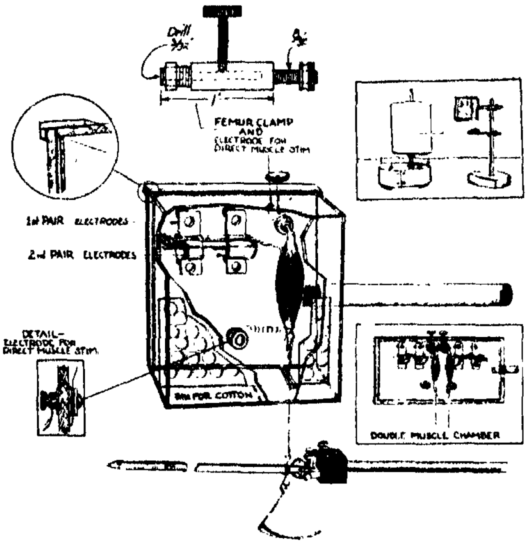
Drill 3/32"
FEMUR CLAMP AND ELECTRODE FOR DIRECT MUSCLE STIM.
1st PAIR ELECTRODES
2nd PAIR ELECTRODES
DETAIL–ELECTRODE FOR DIRECT MUSCLE STIM.
BIN FOR COTTON
DOUBLE MUSCLE CHAMBER

Fig. 1. Drawing of lucite moist chamber with lid partially cut away, showing a nerve-muscle preparation in place and attached to a muscle lever.

Provision is also made for direct stimulation of the muscles. At the bottom of the back panel and near the level of the distal end of the muscle an electrode is introduced. This is an 8-32 roundheaded bolt with spaced washers and nuts around which a fine copper wire can be wrapped to conduct current to the lower part of the muscle (see detail, Fig. 1). On the back of the femur clamp is a binding post, forming a terminal for the opposite side of the electric circuit.

The cover is also of lucite and fits a flange that has been routed into the moist chamber base, forming a tight fit and thus preventing any appreciable moisture loss. The thread leading from the muscle tendon to the writing lever passes through a narrow saw cut in the lower side of the cover.

Near the front of the cover and extending for approximately two-thirds of its height is cemented a perforated plate of lucite, thus making a bin into which moist cotton can be placed. The perforations provide openings through which the moisture passes.

The electrodes, of thin sheet aluminum, are arranged so as to take up a minimum of space and are insulated from each other by any suitable nonconducting material such as mica or thin sheets of plastic, which are held together with De Kotinsky or plastic cement. All of the binding posts are equipped with standard 8-32 dry cell nuts.

The one disadvantage of this chamber is that it is not equipped with nonpolarizable electrodes. However, this type of electrode is rarely used in routine teaching of students. Furthermore, this disadvantage is more than offset by the speed with which the preparation can be put into use. A nerve-muscle preparation can be installed and all connections made in approximately two minutes. Moreover, with the humidity almost at the saturation point, a well-made nerve-muscle preparation will stay viable for several hours without any extra precautions being taken. Once the preparation is in the chamber, it need not be touched again for the duration of the experiment, thus eliminating any possibilities of mechanical or chemical damage which might give artifacts and other faulty results.

The lower right insert shows the back plate of a moist chamber in which two nerve-muscle preparations can be mounted simultaneously. This has a decided advantage over the single chamber, since it can be used on such experiments as the relative fatigability of the parts of the nerve-muscle preparations and on those in which one nerve is narcotized.

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[1] This moist chamber was developed while the writer was teaching physiology at Georgetown University Medical School. A report was not published at that time because during the war years plastic material was not obtainable.

Homogenization of Sputum Specimens With a Paint-conditioning Machine

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To obtain adequate digestion of sputum with either dilute alkali or dilute acid, forceful agitation of the specimen is necessary. Sputum specimens can be shaken mechanically in the ordinary Kahn shaking machine, but much more thorough and rapid agitation is obtained by the use of a paint-conditioning machine. The adaptation of these rugged machines to sputum work was first suggested by Steenken and Smith (*1*) in 1942. At that time the 1-gallon capacity machine was recommended, the gallon container being arranged to accommodate 10 individual sputum bottles. Recently it has been found that a machine similar in type[1] but of 1-quart capacity can be utilized.

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[1] Made by Landon P. Smith, Inc., Irvington, New Jersey.

The container is an ordinary 46-ounce tomato juice can cut down to a height of 13 cm. A tin cover is fabricated just large enough to telescope over the top of the can (Fig. 1). Also illustrated is the separator which slips inside the can and which consists of a central tin cylinder, with an inside diameter of 31 mm., surrounded by 7 vanes, each 3 cm. in width. The cylinder and vanes are 14 cm. in length.

A 50-cc. centrifuge tube, containing the sputum-sodium hydroxide mixture, is slipped into each compartment. Thus, 8 specimens can be shaken at one time. Two wide rubber bands (cut from an automobile inner tube) encircle the separator to help keep the tubes from rattling; a disc cut from rubber belting covers the bottom of the can.

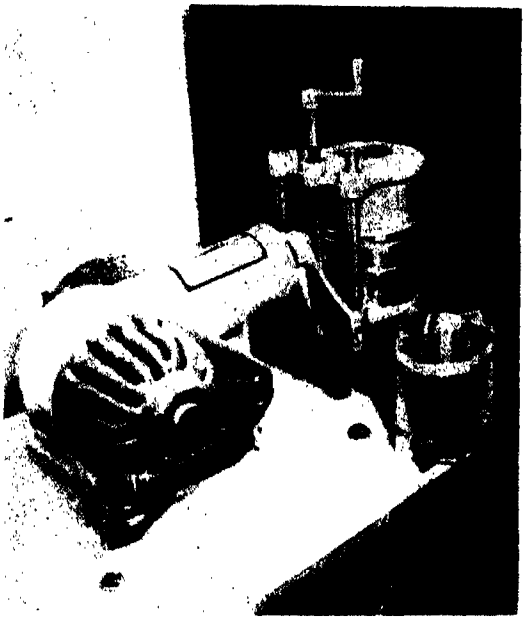

Fig. 1

The centrifuge tubes are of the round-bottom variety. They should be straight edge with no "pourout" lip. The tubes are closed with cork stoppers; rubber corks are not satisfactory. There should be an air space of at least 1 cm. between the top of the sputum sodium hydroxide mixture and the bottom of the cork. When the corked tubes are in place in the can, there is always some variation in the total height of the various tubes with their corks. To compensate for this, a supply of cork discs of varying thickness is kept on hand, a disc of proper thickness being laid on top of each of the lower tubes. This leveling process does not have to be exact, since the telescoping cover, when screwed down tightly, will take up slight unevenness.

When the specimens are shaken in the paint-conditioning machine, complete homogenization is secured in 5-10 minutes. The same centrifuge tubes are used for spinning down the sediment.

Reference

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Estimation of Coenzyme I Through the Uptake of Oxygen

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A new method for the estimation of Coenzyme I has been worked out in which washed, dried brewer's yeast is used as the source of the enzymes, aldolase and triose phosphate apodehydrogenase. The substrate is hexose diphosphate, in the form of the potassium salt. Aldolase splits the hexose diphosphate into dihydroxyacetone phosphate and 3-phosphoglyceric aldehyde; the latter reacts with inorganic phosphate to give 1,3-diphosphoglyceric aldehyde. When Coenzyme I and methylene blue are now added, oxidation to diphosphoglyceric acid takes place, resulting in oxygen absorption, which is measured in the Warburg manometer. Oxygen absorption is steady for a period of 15-20 minutes. When different concentrations of Coenzyme I are employed, we find that if oxygen absorption in microliters during the first 15 minutes is plotted against the concentration in gamma of the coenzyme, the points lie more or less on a straight line (Fig. 1).

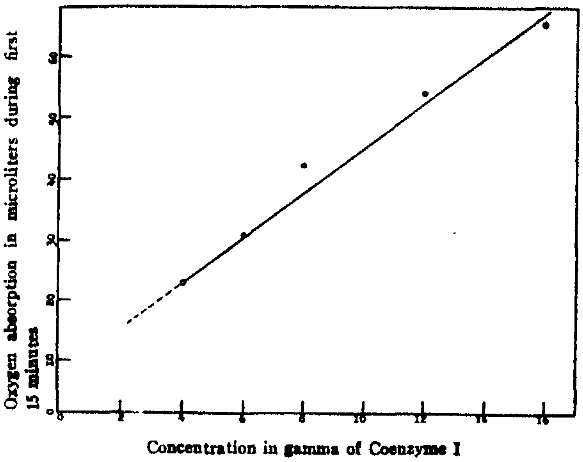

Fig. 1

It has not been possible to wash out the coenzyme completely from dried bottom yeast, but by the use of alkaline phosphate buffer we have succeeded in reducing blank oxygen absorption to a minimum, at the same time retaining maximal potency. There is no induction period, and the reaction is not altered appreciably by the absence of magnesium and manganese ions.

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[1] The author's thanks are due to Prof. J. B. Sumner for his interest in the investigation and to the Haberle Brewing Company, Syracuse, New York, for generous supplies of bottom yeast.

Book Reviews

Practical chemistry for medical students. William Klyne. Baltimore: Williams & Wilkins, 1946. Pp. xvi + 459. (Illustrated.) $6.00.

This treatise on chemistry for medical students is intended to include sufficient chemistry for a proper understanding of the medical sciences of biological chemistry and pharmacology. It is based upon the English system of training medical students and is predicated upon the principle that this fundamental chemical information has not been taught the student prior to his entrance to the medical school.

The book is divided into five parts. Part 1 deals with fundamental scientific ideals, in which such subjects as the keeping of records, the logic of analysis, random variations, and statistical methods are introduced. Part 2, treating of practical methods, is devoted mainly to laboratory technics, melting-point determination, measurements from burettes, and distilling ranges. Part 3 embraces general and physical chemistry. The theory of ionization, acid-base equilibrium, hydrolysis, and colloid chemistry, and the principles of volumetric analysis and membrane equilibrium are embraced in this section. Part 4 includes descriptive inorganic chemistry along with the usual type of qualitative analysis found in textbooks on organic chemistry. The last section of the treatise presents the subject of carbon chemistry, tests for organic radicals, and an introduction to compounds of biological importance, such as carbohydrates, fats, and proteins. In addition, substances of medicinal value, such as acetanilide and sulfonamides, are treated with special emphasis.

Each chapter contains an interesting list of reference books for further reading.

On the whole, the book is well written and embraces a very wide field of chemistry in a manner seldom found nowadays in textbooks in this country.

The author appears to have accomplished the purpose for which the book was written, and in the opinion of the reviewer the subject matter of this text forms an excellent chemical foundation for students in medicine.

John C. Krantz, Jr.

Department of Pharmacology,
University of Maryland School of Medicine

The methods of plane projective geometry based on the use of general homogeneous coordinates. E. A. Maxwell. Cambridge, Engl.: at the Univ. Press; New York: Macmillan, 1946. Pp. xix + 230. $2.75.

This is a textbook on analytic projective geometry in the plane. Plane analytic geometry as ordinarily taught in the freshman year in universities and colleges in the United States is a reasonable prerequisite for understanding it. Although the author insists that he is primarily interested in the methods of projective homogeneous coordinates rather than in the geometrical content of the volume, he nevertheless gives a very satisfactory account of the theory of configurations constructed of points and straight lines, and his discussion of conics might even be called elaborate. Numerous exercises, taken mostly from old examinations, are provided, appropriate reference to the examination which served as the source of each such problem being given.

Doubtless the author had reasons which seemed to him adequate for including no geometrical figures, but to the reviewer it would seem to be good pedagogical practice to illustrate such a treatment with ample drawings and diagrams.

This scholarly work at an elementary level should be supplemented by a similar book on the analytic projective geometry of ordinary space.

E. P. Lane

Department of Mathematics, University of Chicago

Scientific Book Register

Friedgood, Harry B. *Endocrine function of the hypophysis.* New York: Oxford Univ. Press, 1946. Pp. iv + 233. (Illustrated.) $4.50.

Greenstein, J. P. *Biochemistry of cancer.* New York: Academic Press, 1947. Pp. viii + 389. (Illustrated.) $7.80.

Hawk, P. B., Oser, B. L., and Summerson, W. H. *Practical physiological chemistry.* (12th ed.) Philadelphia: Blakiston, 1947. Pp. xiv + 1323. (Illustrated.) $10.00.

Hosmer, Ralph S. *The Cornell plantations, a history.* Ithaca, N. Y.: Cornell Plantations Committee, Cornell Univ., 1947. Pp. xiv + 209. (Illustrated.) $3.00.

Louttit, C. M. *Clinical psychology of children's behavior problems.* (Rev. ed.) New York-London: Harper, 1947. Pp. xviii + 661.

Moore, J. E. *Penicillin in syphilis.* Springfield, Ill.: Charles C. Thomas, 1947. Pp. x + 319. (Illustrated.) $5.00.

Nachmansohn, David, *et al. The physico-chemical mechanism of nerve activity.* (Annals of the New York Academy of Sciences. Vol. XLVII, Art. 4. Pp. 375–602.) New York: Academy of Sciences, 1946. (Illustrated.) $3.00.

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Weaver, Elbert Cook, and Foster, Laurence Standley. *Chemistry for our times.* New York-London: McGraw-Hill, 1946. Pp. xii + 738. (Illustrated.) $2.48.

Weil, André. *Foundations of algebraic geometry.* (American Mathematical Society Colloquium Publ., Vol. XXIX.) New York: American Mathematical Society, 1946. Pp. xix + 289. $5.50.

A National Science Foundation

Statement by William C. Foster, Under Secretary of Commerce, before the Committee on Interstate and Foreign Commerce, House of Representatives, March 7, 1947

THE PRINCIPAL DIFFERENCES BETWEEN the bills before Congress for a National Science Foundation relate to: (1) the form of administrative organization of the proposed Foundation; (2) the question of patent policy with respect to government research contracts; (3) the inclusion of the social sciences; and (4) the distribution of research funds.

ADMINISTRATIVE ORGANIZATION

The difference of opinion as to the form of administrative organization of the proposed Foundation is fundamentally between the following two principles: (1) the usual straight-line organization of Federal agencies consisting of an administrator appointed by the President with the advice and consent of the Senate and responsible to the President; and (2) a part-time board of private citizens which in turn selects a full-time administrator. In the bill which passed the Senate last year a combination of these two administrative arrangements was agreed to—a Presidentially appointed administrator supplemented by a part-time advisory board and divisional advisory committees with the right to report to the President and the Congress independently. H.R. 942 also provides for this in-between arrangement.

On the other hand, the four other bills before your Committee represent an extreme form of the part-time board arrangement. Instead of the board of 9 members in the Magnuson and Mills Bills of last year, these four bills provide for an uncompensated part-time board of 48 members appointed by the President. This large board then selects an executive committee of 9 members, which in turn chooses the director of the Foundation. The executive committee in effect exercises all the real duties and powers of the Foundation. In fact, the 48-man board seems to have no other function than to establish the executive committee and to ratify by majority vote the selection of the director of the Foundation by the executive committee.

I should like to make two observations about this wheels-within-wheels arrangement which starts with a 48-man, part-time committee.

First, if the President or the Congress were dissatisfied with the workings of the Foundation, it would be practically impossible to focus responsibility and to bring about any change in policy under this kind of arrangement. The director could hide behind the executive committee and the executive committee behind a board with 8-year terms.

Second, this 48-man board might also be construed as a bargaining device. Since the board has few functions, it could easily be "sacrificed" in a compromise with the principle of a single administrator, leaving a 9-man board which exercised all of the functions anyway. A compromise on this basis would be similar to the well-known fifty-fifty horse and rabbit stew—one horse and one rabbit.

It seems clear, then, that the practical choice boils down once more, as it did last year, to first, a part-time board of about 9 members selecting its own director, or second, an administrator appointed by the President with the advice and consent of the Senate. Or another alternative is the genuine compromise between these two positions contained in S. 1850 last year and H.R. 942 this year, which consists of an administrator plus an advisory board with direct access to the President and to the Congress. In my opinion there is no question that the basic principle of the single administrator advocated by President Truman represents the only sound public policy. The amount of influence on American scientific development which could be exercised by the Foundation, and the volume of public funds which will be allocated by the Foundation, are too great to give to a part-time body of private citizens. This is especially true if complete discretion is given to the Foundation—as in the four almost identical bills before you—to allocate research funds without regard to geographical distribution or type of research institution. We have here a situation in which a small group of men without direct responsibility to the elected representatives of the people—the President and the Congress—could control the public financial support of science outside the framework of our recognized democratic procedure of coupling responsibility with authority in government. Authority without responsibility is basically wrong in principle.

PATENT POLICY

On the question of patent policy all the bills before you are in agreement that no employee of the Foundation shall be permitted to profit personally by taking out private patents on discoveries arising in the course of his employment with the Foundation. This is also the policy of the Department of Commerce and of most government agencies at the present time with respect to employee patents.

On the other hand, when it comes to applying the same principle to research contractors using government funds, the bills diverge. The four similar bills state that the Foundation shall "protect the public interest and the equities of the individuals or organizations" with which contracts are made without in any way defining the public interest. On the other hand, H.R. 942 provides that discoveries, including patented discoveries, arising in the course of all Federally-financed research shall be available to all, except that research contractors may in exceptional cases retain patent rights in fields where the contractor has made substantial previous investments of his own funds. It should be noted that H.R. 942 (and S. 1850 which passed the Senate last year) extends the public dedication policy to *all* Federally-financed research and not merely to the research financed by the National Science Foundation.

The question of patent policy is a separable question; it affects all government departments and not only the proposed Foundation. It is the subject of a very detailed and careful study by the Attorney General which has recently been submitted to the President for consideration. It is also a subject of study by the President's Patent Committee. Therefore, I suggest that the question of broad patent policy on research contracts be omitted from this bill so as to expedite its consideration and passage; and that government-wide patent policy be considered as a separate problem.

SOCIAL SCIENCES

There was, as you know, a considerable difference of opinion in the hearings last year as to whether the social sciences should be included in the National Science Foundation. Because of the similarity of terms, social science has carried an unfortunate connotation of social welfare activities or of a vague impracticability. Actually, social science, under more specific terms such as statistics, business analysis, and industrial psychology and management, is an indispensable tool in the operation of any modern large-scale private enterprise and in the operation of Federal, State, and local governments. The Congress itself has acted on this understanding in some of the provisions of the Legislative Reorganization Act of 1946, especially with respect to providing professional staffs to the standing committees.

Social science, however much it may be misunderstood when referred to in that general term, is a part of our everyday life in the 20th Century. We need more and better knowledge about our society if we are to be successful in dealing with some of the complex and difficult problems which we are facing today and in the years ahead. As to the kind of research to be fostered by the Foundation in this field, the Congress will, of course, be able to guide and control this matter through the review of annual appropriations, as it has done in connection with the extensive applied social science activities which have long been part of the operations of other Federal departments and agencies.

Developments in the natural sciences are far in advance of mankind's ability to control the physical forces which they have unleashed—such as atomic energy. As an engineer who has witnessed the impact of technological changes on our society, I am particularly aware of the importance of developing the sciences that deal with man and his institutions. In fact, the future of our society and of man himself may depend on whether we gain sufficient social knowledge in time to control the powerful forces of nature as they have come to be applied. A National Science Foundation which would provide only for the natural sciences would place the social sciences at new and further disadvantages in competing for the best young talent of the country in institutions of higher learning and in research.

DISTRIBUTION OF RESEARCH FUNDS

H.R. 942 contains a formula under which 25 per cent of the research funds (except for national defense research) of the Foundation would be allocated to land-grant colleges and state universities—15 per cent in proportion to the population of each state and 10 per cent in equal shares to all states. However, no individual contract can be made unless it is consistent with the general program and standards of the Foundation. Another 25 per cent of the research funds would be earmarked for nonprofit institutions. The other four bills provide no such guide to the Foundation in the distribution of research funds.

Under practically all legislation providing Federal aid to states there are rather rigid formulae for the distribution of funds—formulae based upon population, area, matching of funds, and various other objective factors. Very little discretion is left to the administrative agencies. The research funds to be allocated under this legislation are not, of course, strictly comparable with Federal aid to the states. On the other hand, some of the same considerations are applicable. Scientific ability is widely enough distributed among the various areas of the United States so that one-quarter of the Foundation's research funds can be expended according to a geographical and population formula without much danger of lowering the quality of research. At the same time such a provision provides some safeguard against the possibility of unnecessary concentration of funds in a few favored institutions. Similarly, it is only proper that the Congress provide some guide to the Foundation on the amount of funds to be allocated to nonprofit institutions, which have hitherto carried the burden of the basic scientific research with which this legislation is concerned. I would urge that your Committee give serious consideration to incorporating into the bill certain minimum standards for the allocation of funds, and yet leave sufficient flexibility so that the quality of research is maintained at the highest level.

OTHER PROVISIONS OF THE BILLS

I believe that the four points just discussed cover the most important variations in the bills which you are considering. In most other major respects the bills are substantially the same. I am glad to note, for example, that all the bills provide for the coordination of the scientific activities of the Federal Government through a standing Interdepartmental Committee on Science, and that the existing scientific agencies of the Government may receive research contracts from the Foundation as a supplement to their regular activities and appropriations, and not in substitution therefor. These two provisions are of great interest to the Department of Commerce, which includes several of the important scientific agencies in the Government, such as the National Bureau of Standards, Weather Bureau, and Coast and Geodetic Survey in the natural sciences, and the Census Bureau and Bureau of Foreign and Domestic Commerce in the social sciences.

In conclusion, let me say that the general objectives of this legislation have the fullest support and endorsement of the Secretary of Commerce, for whom I am speaking, and of the President. (I am, of course, in no sense committing the President on all the specific points I am raising.) On the other hand, there is serious question as to whether the Foundation could operate properly and in the public interest under some of the forms of administrative organization which have been proposed. The combination of the best features of the single administrator and an advisory board which were worked out last year, and which are incorporated in H.R. 942, seem to be the desirable solution of this problem. With respect to the social sciences and the allocation of research funds, the provisions of H.R. 942 also appear to be preferred to those of the other bills. Finally, it is my judgment that the patent problem is a separable issue and that government-wide patent policy should be considered independently of the Science Foundation Bill.

It has become increasingly recognized that widespread support of science is essential to technological advance, economic progress, and higher standards of living and to our national security. There is no question but that the public financial support of science which you are considering will in the long run represent a small expenditure compared with the great gains which experience has shown we may confidently expect.

A National Science Foundation

Statement by James B. Conant, president of Harvard University, before the Committee on Interstate and Foreign Commerce, House of Representatives, March 7, 1947

I APPEAR BEFORE YOU TO URGE FAVORABLE action on identical bills H.R. 1815, 1830, 1834, and 2027, which are concerned with a National Science Foundation. I wish to address myself at the outset to those sections which empower the Foundation to grant scholarships and fellowships. For to me these are by far the most important parts of the bills. I make this statement advisedly, for there is no use considering ways and means of spending money on research unless first-rate men are available to do the work.

In all the discussion about research that goes on in these days, an obvious fact is sometimes overlooked, namely, that it is men that count. And today we do not have the scientific man power requisite for the job that lies ahead. The bottleneck of our scientific advance is essentially a man power shortage, and unless something is done about it, the bottleneck will be more constricted a decade hence. Now let no one imagine that, like some of the man power shortages in the war, this can be cured by mobilizing and training for a short time the first people who come to hand. Scientific and technical advances depend on quality as well as on quantity or, to put it another way, on the quantity of exceptional men. These men have to be located when they are young and then given a long and expensive scientific education. If the proposals before you become law and Congress appropriates the money, we will see a flowering of scientific work in this country the like of which the world has never seen before. For only in this Nation, where universal education reaches to the high school level, is it possible to locate the hidden reservoir of talent which, if tapped, can enrich our life and that of all mankind.

The bill before you provides for a long-term plan. The measures proposed would have been desirable even if there had been no war and no consequent deficit in our scientific and technical man power. To the extent that we fail to cure this deficit in the next few years by proper governmental action, to that extent a Federally-supported scholarship and fellowship program is even more essential.

The arguments in favor of Congress providing for such a program and making adequate annual appropriations can be summarized as follows:

(1) The welfare of a free society in an industrial age depends on a continuous advance of science and the application of the new knowledge to useful ends.

(2) Both the advance of science and the application of science to industry, to medicine, and to agriculture depend on the quality and quantity of scientists and engineers available in a nation.

(3) The supply of men depends on the number trained and the innate ability of those who undertake the special training.

(4) The scientific professions in question require a long and expensive education beyond high school.

(5) This education is of such a nature that it can be given at only a relatively few centers in every state.

(6) Therefore, unless a student lives in one of these centers, his professional training must be costly for he must pay for room and board away from home as well as other expenses.

(7) The consequent financial barrier now prevents many boys and girls of high ability from going on with an advanced education. Much talent is lost to the Nation by this educational waste.

(8) To right the balance, a Federally-supported scholarship and fellowship program is required.

Such is the argument in a few words in terms of the peaceful development of the country. When we turn to consider the possible contingency of war and measures for national defense, the argument for finding and developing scientific talent is even stronger. There is no longer any argument about the role of science in a defense program. If we are to remain strong from a military standpoint, as I believe we must until international agreement provides a reasonable plan of disarmament, our need for scientists is as great as our need for Army and Navy officers. A relatively few men of great ability, imagination, daring, and with the proper training as officers of the armed forces have more than once in history determined the fate of nations. A relatively few men of great scientific ability and imagination, and thoroughly trained, can play a part in building the military strength of this Nation in the next decade to a degree that can hardly be imagined by those who are not close to the research and development program of the Army and the Navy.

Granted that in terms of the industrial development of the Nation, in terms of public health, and above all in terms of military strength, we must find and train our scientific talent, you may ask why a Federally-supported program of scholarships is required. I wish that all who raise this question could take the time to read the last section of the document entitled, *Science: the endless frontier*. The answer to the doubting Thomases is there set forth in detail. I shall endeavor in this statement to give only a brief summary of the important points.

The facts presented in that report and in other documents prove convincingly that we have been to a large degree wasting our most valuable national asset—the innate ability of each new generation. Table III on page 165 of *Science: the endless frontier*, for example, illustrates what every educator who probes deeply into this matter knows, namely, that *outside of the university towns and cities*, whether a student attends college or not is very largely a matter of family income. The figures quoted in this table refer to the college attendance just before the war of *superior* Milwaukee High School graduates (note the adjective, please). Here it is shown that while 100 per cent of those whose families had an income of $8,000 or higher attended college, the figure dropped to 44 per cent for the income range, $3,000–$2,000, and to 20 per cent for those under $500. These percentages are not for the entire class—far from it. These are the *superior* graduates of the high school—all college material. Similar evidence has been obtained by many other studies. I believe it is a conservative estimate to say that before the war there were as many boys and girls of real ability who graduated from high school but who did not attend a college as there were students of the same ability going on for further education. Once the veterans' educational benefits are over, the same situation will reoccur in this country unless steps are taken.

Let me remind you of what the report calls "The Educational Pyramid." This is an attempt to give an over-all statistical picture of the present educational selection in the United States; it represents the average for the whole country.

Starting with 1,000 pupils enrolled in the fifth grade (figures for earlier grades are confusing because of pupil retardations), the following figures show the extent to which they are reduced in each successive year:

Elementary school:	
Fifth grade, 1930–31	1,000
Sixth grade	943
Seventh grade	872
Eighth grade	824
High school:	
First year	770
Second year	652
Third year	529
Fourth year	463
Graduates, 1938	417
College:	
First year	146
Graduates, 1942	72

Now there are many reasons why boys and girls drop out of school, but there can be no question that to a large extent financial considerations play a part. This is particularly true in regard to the drop from 417 graduates of high school (per 1,000 of fifth graders) to 72 graduates of college. To the extent that family finances are the determining factor, potential professional talent is lost for the service of the Nation.

There is one very important point which I should like to emphasize in connection with the proposals I am urging today. We are concerned here only with the advanced education beyond high school of certain types of professional men and women; we are not concerned with the problem of education beyond the high school in general. I am not advocating a Federal subsidy so that everyone can go to college—not even everyone who under our present standards can get by the entrance examination boards. The question of expanding public education beyond the high school for vast numbers is an entirely different story. As I see it, the pattern for public education in the future will be that of expanding the opportunities for education beyond high school as far as possible locally; that is, through institutions somewhat similar to those we now call junior colleges, two-year terminal institutions. This is the economical way to provide so-called higher education at public expense, for the student lives at home.

But there are certain types of education which cannot be given in every small city or town. They require very specialized staffs, expensive laboratories, large libraries. Training for these professions is the work of the universities or, in the case of engineering, the universities and engineering schools. To attend these institutions the poor boy needs support. It is in the interests of the Nation to give him this support. For the reasons I gave at the beginning of these remarks, it is imperative that this be done in the case of the future research worker in physics, chemistry, and biology, and the future engineer.

I hardly need remind this Committee that Congress, in considering the recruitment and training of naval officers, recently recognized the educational situation which I have just explained. By the adoption of the Holloway Plan the Federal Government has equalized the opportunity for college education for a limited number of talented youth from low-income families if they are enrolled in the NROTC units. Authorization was given, I believe, for 14,000 regular students in NROTC units in 52 colleges and universities. The cost of tuition, fees, and textbooks will be paid by Federal funds. Uniforms will be provided, and students will receive retainer pay for other expenses during college at the rate of $600 a year. Undoubtedly, a great many very promising young men will obtain a college education in this manner who might otherwise have received little or no training beyond high school. The recruiting and education of the regular Navy and Reserve Officers will be facilitated. On both counts the welfare of the Nation is promoted. I congratulate Congress and the Navy on the adoption of this plan. But measured solely in terms of our military strength, can the Nation afford not to adopt a somewhat similar scholarship program for the scientists? If you envisage the nature of our present and future armaments as I do, you will agree that the need for outstanding scientists is comparable to the need for naval officers.

The type of young man who should and will apply for the Navy program, by and large, will not be the type who would benefit from the Federal scholarship program I am advocating. The Navy needs, for the most part, future operators, men of action and decision. But the mechanisms they operate must be designed by research and development men, and the work of those applied scientists in turn rests on the discoveries of the pure scientists. The bill I am supporting, of course, provides for no counterpart of the NROTC. And none is needed. The recipients of the scholarship would be free to choose their own college or university. Fortunately, it is no longer necessary to argue that a good selection can be made from among the high school graduates of the country. This has now been demonstrated by our war experience and is a premise of the Holloway Plan. The same type of nation-wide aptitude test now used by the Navy would be used with perhaps a somewhat different slant. Final selection, as in the Holloway Plan, might well be in the hands of State Selection Committees.

All the details of administration should be left to the Foundation and its officers, as the bill quite properly does. However, I think that provision of Section 9 (a) is wise. It provides "that the Foundation shall award the available scholarship or scholarships or fellowship or fellowships to the applicants in such manner as will result in a wide distribution of scholarships and fellowships among the States, Territories, possessions and the District of Columbia." I am inclined to think that the administration of the scholarships might, if the Act permits, be along the lines indicated in the document to which I earlier referred. For example, on page 146 of *Science: the endless frontier* is given an allocation of the proposed 6,000 scholarships a year on a state basis. I believe this recommendation or an approximation to it would be sound national policy for two reasons:

(1) It emphasizes local administration, which I think highly important in all educational matters.

(2) It will stimulate the educational development of many states which do not at present contribute their share of talent. We should recruit our professions more uniformly from the country and by so doing stimulate talented young people in more sections of the country to take the necessary advanced education which is required. At present our research scientists are drawn in large measure from a relatively few states. That is not a healthy situation. I believe a Federal program of scholarships for certain professions administered on a state quota basis would in a generation change this picture. It should be understood, of course, that the recipient of the scholarship could enter any institution he chose. The universities within each state would then have to compete for the Federal scholars both within and without their region by giving as good scientific and professional training as could be obtained anywhere in the country.

The scholarship and fellowship program set forth in *Science: the endless frontier* called for 6,000 scholarships annually awarded for four years to high school graduates —a total of 24,000—and a total of 900 graduate fellowships. The maximum annual total cost of the plan, it was estimated, would be $29,000,000 after the fourth year of operation. Although I do not think this amount of money too large in view of the paramount importance of the Federal scholarship plan for scientists in terms of the national welfare, I do recognize the need this year of keeping Federal expenses down. I therefore suggest that the number of scholarships and fellowships might well be set at half the figure I have just given. I should not advocate writing this or any figure into the bill. I assume the matter would be handled in connection with the appropriation which must be made if the bill becomes law. A total expenditure of somewhere around $14,000,000 for the plan when it is in operation seems to me reasonable, particularly when one remembers that this will provide for fewer scholarships (12,000) than the number authorized under the Navy plan, which calls for a maximum of 14,000. There is no doubt in my mind that a program of the dimension I have just mentioned would be very worth while indeed. If such a scheme could be operated for five or six years, ample evidence would be accumulated to enable Congress and the American people to assess the value of the plan.

Now, in conclusion, may I once again endorse the whole proposition—the establishment of a National Science Foundation as specified in the legislation I am supporting. I have confined my remarks to the scholarship program because I believe it is of the first importance. But the other features of the bill—the graduate fellowships and the support of research—are likewise of great significance for the future welfare of the Nation. I venture to hope that your Committee will report favorably on this matter and that the Senate will in due course take similar action. We need a Science Foundation both to forward our domestic economy and to strengthen our military establishment.

A National Science Foundation

Statement by Vannevar Bush, Chairman, Joint Research and Development Board, before the Committee on Interstate and Foreign Commerce, House of Representatives, March 7, 1947

THIS STATEMENT HAS BEEN SUBMITTED to the Bureau of the Budget, although time has not been sufficient to permit a reply. I want to make it clear, therefore, that I do not purport to represent the opinion of the President.

It is quite unnecessary for me to take up your time with an argument tending to prove that our economic and industrial progress, our national security, and our national health and welfare are dependent on continually extending that knowledge of our environment which comes only from basic scientific research.

It is equally unnecessary to make a lengthy argument that the time has come for the Government to intervene in support of basic research. The devastation of a large part of Europe has effectively eliminated many of our principal sources of fundamental scientific knowledge. Within the United States, our principal sources have always been the nonprofit educational institutions and endowed foundations. These institutions now are faced with increasing costs and decreasing income. We must, therefore, replace the lost sources of new scientific knowledge and strengthen those which we still have.

I believe that these statements reflect the views of most of the scientists, educators, and industrialists in the United States. In the last session your Committee heard a number of leaders in these fields testify to that effect. Committees of the Senate heard the testimony of well over a hundred such leaders. With one exception, all of those who testified before committees of Congress on science legislation supported the proposition that the Government must undertake the support of basic scientific research.[1]

Now, the witnesses at those hearings differed rather widely in their views as to precisely what action the Government should take, how far it should go, and what kind of instrumentality should be established to take such action. Several bills were introduced in the 79th Congress, and there were many drafts and redrafts of some of them. In addition, there were many discussions and conferences between interested scientists and educators, and members of Congress. In the course of these discussions the various divergent views were analyzed, and many of the differences were reconciled. The issues were thus narrowed so that you now have before you only two different bills, H.R. 942 and H.R. 1830. Since H.R. 1815, H.R. 1834, and H.R. 2027 are identical, I shall refer to them collectively as H.R. 1830.

Now, both bills have many desirable objectives in common. They both establish a National Science Foundation as an independent agency. They both provide that the Foundation should support basic research. They both provide that, with respect to matters affecting the national defense, the Foundation may not only support basic research but also perform applied research and development. They both provide for the award of scholarships and fellowships in science, to young men and women of outstanding ability, and neither bill attempts to limit the recipients to any particular field of scientific study or to retain any control over them after completion of their studies. Both bills contemplate an internal structure for the Foundation composed of divisions, each of which is to be concerned with a major field of science, and in addition, a division of scientific personnel and education. Moreover, they both permit additional divisions to be established when necessary or desirable. Both bills provide for an advisory committee of specialists to be attached to each division. Both bills provide for correlation of existing government research activities. Both bills provide for international cooperation in research and for fostering the interchange of scientific information, both domestically and internationally. Several other provisions which these bills have in common give to the Foundation special authority and certain exemptions from existing provisions of law. These provisions recognize the unique nature of the Foundation and will greatly facilitate its operations. I need not go into detail as to why all of these objectives are desirable and necessary, but I would like to point out and analyze the principal differences between the two bills.

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[1] See the record of the Hearing before a subcommittee of the Committee on Interstate and Foreign Commerce, House of Representatives, 79th Congress, 2nd Session, on H.R. 6448 and of the Hearings on Science Legislation before a subcommittee of the Committee on Military Affairs, United States Senate, 79th Congress, 1st Session, pursuant to Senate Resolution 107 (78th Congress), and Senate Resolution 149 (79th Congress).

The most important of these differences is the locus of ultimate authority and responsibility within the Foundation. H.R. 942 vests this authority and responsibility in a single administrator who would act with the advice of a part-time board. On the other hand, under H.R. 1830 the Foundation would be headed by a board of outstanding men, which in turn would appoint an administrator to carry out its policies and to handle the administrative affairs of the agency.

Now, it has been the experience of the Government that when commissions or boards attempt to handle operational details, they are very apt to run into difficulty. Disagreements among the members can cause lengthy delays. Conflicting orders may be given by the several members, and disputes and hard feelings can arise over matters of administrative detail. I do not feel, therefore, that a commission or board, as a group, should be directly active in the actual operations of an agency. But there is no reason whatever why this should occur. Several government agencies which carry on extensive operations, as opposed to performing quasi-judicial functions, are organized on the basis of reposing the ultimate control in a group of men. As a matter of fact, I have had a good deal of experience with one such agency, the National Advisory Committee for Aeronautics. This agency consists of a Committee appointed by the President, with a full-time paid administrator to carry out policies established by the Committee and to handle all the administrative affairs of the agency.

The organization contemplated by H.R. 1830 would be very similar to that of the NACA, and there is every reason to anticipate that it would function as effectively. If you fear that under H.R. 1830 the executive committee of the Foundation might attempt to concern itself with operational matters, a provision could be inserted in the bill, expressly prohibiting such activities. I do not think, however, that such a provision would be necessary. The full membership of the Foundation is required to meet only once a year, and the executive committee is required to meet only six times per year. Although either could meet more often, it seems to me that the intent of these provisions is clear, that neither body should be in continuous session. Moreover, the salary provided for the director in H.R. 1830 is adequate to secure an excellent administrator for this position. He would be expected to be in charge of all the administrative affairs of the Foundation.

There was considerable argument at the last session of Congress, to the effect that the Foundation should, at all costs, be free from political controls. These arguments are valid only in the sense that the operations of the Foundation should be free from the pressures of any special interests whatever. The Foundation is to be a government agency, and the Government is designed and established to be of the people and for the people. The Foundation should, therefore, be fully responsible to the people, and this means to the Congress of the United States. Moreover, the Foundation should not be insulated from the Executive Branch of the Government. I believe that it should be subject to the operating procedures, policies, and controls to which other agencies are subject, and which are necessary for an efficient and effective Executive Branch. It should, therefore, be subject to the controls of the Bureau of the Budget with respect to appropriations, transfers of funds, and other matters. It should also be subject to the Civil Service laws and regulations, except with respect to scientists in a very limited number of special cases.

Certain other exemptions from existing provisions of law and certain special authorizations are necessary to enable the Foundation effectively and economically to carry out its unusual functions. I have in mind such provisions as that permitting the Foundation to enter contracts without requiring performance bonds and without advertising for bids, and the provision that part-time specialists, by reason of their service with the Foundation, would not be subject to the provisions of certain criminal statutes, except with respect to matters affecting the Foundation. But these special authorities and exemptions, as they now appear, contain within themselves their own limitations, and they would not and should not place the Foundation outside any other of the usual procedures applicable to all executive agencies.

In addition to these government-wide administrative controls and procedures, I feel that the administrative head of the Foundation should also be subject to the general control of a board of outstanding men and women with widely diversified training and experience. The Foundation will be faced with many different but exceedingly complex and highly technical questions. For example, it must annually evaluate the relative importance of scholarships, basic research, international undertakings, and publications in terms of the over-all national welfare. Within its allocation for research, the Foundation must determine the relative importance of the different fields of science. Finally, it must be able to evaluate, on the basis of their scientific merits, not only the relative importance of the various specific projects but also their potential effectiveness. Decision of these questions will require not only extensive and varied scientific knowledge but also broad and sound concepts of the Nation's best interests. In other words, the decisions must be wisely made from the standpoint of many considerations.

In the long run and in general, the Congress should, as representative of all the citizens, make decisions of policy. It is obvious, however, that the Congress lacks sufficient time to inform itself as to the various considerations involved in making these particular decisions. It must therefore delegate to others the power to make them, retaining its ultimate control through annual reports and appropriations. In my opinion, this delegation should not be to one man but should be to a group of the ablest men and women in the United States, drawn from all parts of the country, who would represent the different fields of science, education, and public affairs.

I cannot overemphasize the importance of securing the services of the ablest possible individuals to guide the Foundation. A board which is only advisory would bear responsibility for the decisions of the administrator, but would not have any real authority to control those decisions. I believe that in order to be sure to secure members of the requisite caliber, it is essential to give them authority commensurate with their responsibility.

Now, the two bills are very different in their treatment of inventions made in the course of research supported by the Foundation. H.R. 1830 directs the Foundation, in making contracts and other arrangements for research, to consider the public interest and the equities of the research organizations and individuals with which it deals. It further provides, however, that no officer or employee of the Foundation shall derive any personal benefit from inventions which may be made by him in the course of performing his assigned activities for the Foundation. This, I believe, is as far as this legislation should go in controlling the policies of the Foundation. I believe that an able director, guided by this directive and by more detailed policies which would be established by the Foundation, would protect the public interest and, at the same time, be fair to the individuals and organizations which will be performing research for the Foundation.

Now, there are three provisions in H.R. 942, the necessity of which is open to some question. I refer to Section 5, which provides for the apportionment of certain percentages of the Foundation's funds among the several states, among different types of institutions, and for different fields of research. The provisions for allocating fixed percentages of funds to nonprofit institutions and for certain named fields of research are questionable only on the grounds that they are unnecessary. I am sure that both quotas would be exceeded in practice.

The principle of wide distribution of research appropriations throughout the country seems to me basically sound. It is necessary, if our basic scientific research is to remain energetic and fruitful, that we maintain and strengthen many different research organizations throughout the country. It seems to me, however, that such wide distribution could be effectively accomplished by the Foundation under the terms of H.R. 1830. The large membership of that board, together with the stipulation that its members shall be selected so as to represent scientific opinion in all parts of the country, constitute an effective guarantee that the Foundation's funds will not be concentrated in a few large institutions or in any one section of the country. In my opinion, therefore, the policy expressed in Section 15 (h) of H.R. 1830 is quite adequate to assure that the desirable purpose of strengthening our smaller research organizations will be accomplished without imposing upon the Foundation the technical difficulties and the burden of detailed accounting which would be required by the terms of H.R. 942.

Similar considerations apply to the provisions in both bills for geographical distribution of scholarships and fellowships. I feel that scholarships and fellowships should be distributed as widely as possible, but with due regard for the ability of each applicant. Consequently, I prefer Section 9 (a) of H.R. 1830 to the corresponding provisions of H.R. 942 in that it subordinates the factor of residence to that of ability.

One or two further points of difference between the bills seem to deserve brief comment. One is the provision in each bill concerning the divisional structure of the Foundation. H.R. 942 establishes eight divisions and authorizes the administrator, with the advice of the board, to establish up to three additional divisions. H.R. 1830 establishes five divisions, but it authorizes the Foundation to abolish any of them, except for the Division of National Defense, as well as to establish new divisions. This allows greater flexibility than the arrangement of H.R. 942. Although the divisions provided in each bill cover most of the basic fields of research in which the Foundation, as presently contemplated, is likely to engage, it is quite possible that, from time to time, it will be expedient to rearrange these divisions.

In the last session of Congress there was considerable controversy over a provision in the Kilgore-Magnuson Bill which would establish, within the Foundation, a division of social sciences. This provision was eliminated on the floor of the Senate, and I believe that was a wise move. But I do think that the controversy was unfortunate. If we, as a democratic nation of free individuals are to survive, we must seek to understand the forces which affect our social organizations in order that they may be anticipated and guided in safe directions. A large amount of research is already being devoted to various aspects of the social sciences, both by the Government and by private individuals and organizations. Much more could be done to advantage. In view of the magnitude and complexity of this field, however, it seems to me that the Foundation should carefully survey it with a view toward determining those areas which could be made the subject of fruitful research under its auspices. Under H.R. 1830 this could be done, and I hope it will be done. But it is well to make research in the social sciences permissive rather than mandatory.

Finally, I should like to say a few words about the size of the undertaking which you are considering. The Foundation, particularly at the outset, need not be a grandiose venture. In my report to the President, *Science: the endless frontier*, I suggested a budget, for the first year, of $33,500,000, including $7,000,000 for scholarships and fellowships. That budget was carefully prepared on the basis of replies to questionnaires sent to more than 300 educational and other institutions. I still think the estimate is reasonable, but two factors have intervened to make an initial appropriation of this size unnecessary. The Servicemen's Readjustment Act of 1944 will materially help to reduce the accumulated deficit of trained scientists and technicians. That does not mean that the Foundation need not commence its scholarship program immediately. It takes from four to seven years to train a scientist, as you know. However, it will lessen the urgency of the demand and permit the Foundation to plan its program carefully and begin it gradually. The Foundation will then be in a position to assume the full burden when the benefits of that act cease to be available.

The second, and greater factor, is the immediate availability of certain funds which can be transferred from the Services. The Army and Navy have shown great vision in undertaking basic research as an interim measure. Many of their research projects can, and, I am informed, will be transferred to the Foundation, supported by funds already appropriated by the Congress. These funds will materially decrease the initial appropriation necessary for the operations of the Foundation.

Of course, neither of the two bills before you is perfect, but H.R. 1830 is the best bill I have seen on the subject of science legislation. I have written to your Committee making several suggestions for changes. You will wish to make others. But those suggestions are primarily on details. What is of vital importance is that a National Science Foundation be established, and that it be established as promptly as is consistent with full examination of the matter by the Congress.

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Programs for Medicine and National Health in the USSR

Stuart Mudd, *President of the American-Soviet Medical Society* and
Professor of Bacteriology, Medical School, University of Pennsylvania

OBSERVATION OF SOVIET RESEARCH activities was recently made possible during a visit to the USSR organized by Robert L. Leslie through the American-Soviet Medical Society and the *American Review of Soviet Medicine.* The preceding issue of *Science* described some of the work being done in experimental laboratories on problems of mental health and communal hygiene. This installment reports further on work being done by leading Soviet institutions, especially in preventive medicine and rehabilitation of war wounded.

THE PREVENTION OF SPECIFIC INFECTIOUS DISEASES

The Central Institute of Epidemiology and Microbiology of the Ministry of Public Health, with grounds and buildings in the outskirts of Moscow, plans a considerable extension of its facilities over a period of 5–10 years. Diphtheria and tetanus toxin, toxoid and antitoxin, smallpox vaccine, typhus vaccine, polyvalent dysentery bacteriophage, and BCG vaccine for tuberculosis are produced here on a large scale. During the war this Institute was evacuated to the Ural mountains, where production of the needed biologicals was carried on. Production methods are standard, but less well provided with mechanical appurtenances than in this country.

Smallpox and BCG vaccine for shipment to remote parts of the USSR are dried *in vacuo* from the frozen state, and, according to Academician Michal Morosow, the results are most satisfactory. Typhus vaccine is produced by the mouse-lung method under the direction of Maria Krontovskaya. BCG vaccine is produced by growing the Calmette strain on a synthetic medium containing glycocoll, asparagine, and salts. Polyvalent dysentery vaccine contains Shiga toxoid and the five classic Flexner strains. Polyvalent dysentery bacteriophage preparations were also prepared. These were scattered during the war in soil, sewage, and food as well as being given by mouth. The director, L. Jankelevich, said that statistics regarding bacteriophage were weak; he had observed its therapeutic use, however, and thought the results were good.

Polyvalent bacteriophage as a prophylactic against the diarrheal diseases is also produced in the All Union Institute of Biological Prophylaxis of Infections, of which Z. V. Ermolieva is the director. This is a highly polyvalent preparation containing phages against *Escherichia coli, Shigella dysenteriae* (Shiga), *S. paradysenteriae* (classic Flexner types), *Salmonella paratyphi* (A and B), *Proteus,* and *Pseudomonas pyocyanea.* The polyvalent phage is given children in children's gardens and summer camps every 10 days from May to October. Prof. Ermolieva cited experiments in which groups of children had received this phage and control groups physiological salt solution, with a lower rate of incidence in the protected than in the control groups. Statistical studies are promised for the *American Review of Soviet Medicine.*

Later, in the Institute of Microbiology, Epidemiology, and Bacteriophagy of the Ministry of Health of the Georgian Republic in Tbilisi, we observed the preparation of polyvalent dysentery bacteriophage both as broth filtrate and in dry tablets. V. S. Antadze, director of research there, stated that prejudice against bacteriophage in the USSR has been overcome by controlled experiments with human populations matched as to age, weight, etc. The main point, he said, is to use many types of phage active against Shiga, Flexner, Hiss, and Sonne types of dysentery bacilli. Phage is given by mouth. For treatment, administration must begin as early as possible in the disease. In early acute dysentery, Dr. Antadze stated, there is almost immediate cure; the patient feels better in two or three days if the phage types coincide with the types of the infecting organisms. Effectiveness is very low in chronic dysentery, however.

Favorable results were also being obtained at the Institute with polyvalent bacteriophage against *Eberthella typhosa.* Cases treated in the first days of clinical symptoms were believed to be shortened to 14 or 15 days duration. Polyvalent typhoid phage was used both for prevention and treatment. It had not been successful, however, in clearing up typhoid carriers.

BCG vaccine, we were assured in the Institutes in Moscow and also in Tbilisi, where it is prepared for the Georgian Republic, is now given to every newborn child in the USSR. In Georgia, for the past two years, BCG has been administered by mouth to all newborns within the first week of life. It is also administered to populations under special risk, such as nurses in tuberculosis hospitals.

Another interesting class of anti-infective agents has been developed in the Institute of Biological Prophylaxis of Infections. According to Prof. Ermolieva, lysozyme from the horse-radish has been used since 1934 in otolaryngology and ophthalmology. Egg-white lysozyme prepared according to Bordet is used as a spray in laryngitis. According to Prof. Ermolieva, "All the best singers insist on it."

Another anti-infective called "erythrin" is extracted from erythrocytes. This is said to be bactericidal against

Corynebacterium diphtheriae, staphylococci, and streptococci. When sprayed into the nose and throat four times per day for four days in one to three courses, it is reported to clear up the chronic diphtheria carrier.

Preventive measures against rabies were touched upon by V. Ushakov, of the Institute of Experimental Medicine in Leningrad. Dr. Ushakov began work on hydrophobia in the first Pasteur Institute in Russia, organized in 1886. He joined the staff of the Institute of Experimental Medicine in 1890, where he is still working at 81 years of age.

REHABILITATION OF THE WAR WOUNDED

The Soviet Union has established some 300 hospitals for war veterans. Special schools for injured veterans are maintained by the Department of Public Welfare. There are some 17 institutes for special surgical rehabilitation of the war wounded and victims of industrial and other accidents. The largest of these is the Central Institute of Traumatology in Moscow. N. N. Priorov, Vice-Minister of Public Health of the USSR and director of this Central Institute, personally conducted us through this splendid hospital.

During the war special workshops were organized in the hospitals. In these an effort was made to learn the experience and training of each man and to plan his rehabilitation accordingly. At the present time special schools for injured veterans are maintained under the Ministry of Social Welfare. Invalids are divided into three groups: (1) people unable to work or to take care of themselves, (2) people unable to work but who can take care of themselves, and (3) people who can work, even though their kind of work may need to be changed. The main source of psychological disturbances is in those who do not know what work to do; when work is found for them, as a rule they become mentally sound.

Cases were described and shown to us of veterans who had lost both hands; the bones of the forearm were separated by the Krukenberg operation. These men seemed quite unself-conscious about using their arms for greeting and other purposes. Veterans who had lost both hands had entered law school and a school of economics. Those blind or without both legs were seen, as were others with spinal and facial injuries in various stages of plastic and restorative surgery. Their spirit and the relationships between staff and patients impressed us as strikingly fine. The injured veterans included women as well as men.

An interesting accessory to surgery was shown us in the case of hyaluronic acid prepared from bovine vitreous humor. This was injected intragluteally for softening scars and to facilitate healing.

Special workshops and factories are devoted to the manufacture of prosthetics. These are being revised with the aid of prosthetic devices purchased in America.

Poliomyelitis is treated in acute stages by neurologists; in late stages, by orthopedic surgeons. Transplantation of muscles is sometimes resorted to. The Kenny method is not used.

THE INSTITUTE OF BIOLOGICAL AND MEDICAL CHEMISTRY

The 20 medical institutes visited included some of those described in the report by A. B. Hastings and M. B. Shimkin (*Science*, May 17 and 24, 1946). So manifold are the scientific activities in Moscow and Leningrad and to a less extent in other cities of the USSR, however, that our experiences only partly paralleled those of Hastings and Shimkin and included very few, indeed, of the institutions visited by Selman A. Waksman as a guest of the Academy of Sciences of the USSR (*Sci. Mon.*, April 1947) and Edward L. Young with a party from Russian Relief (*Soviet Russia Today*, 1946, 15, 12).

A high point scientifically was the Institute of Biological and Medical Chemistry of the Academy of Medical Sciences of the USSR. This splendidly organized Institute, under the direction of J. O. Parnas, comprises five principal Divisions: (1) Intermediate Nitrogen Metabolism, (2) Protein Biochemistry, (3) Chemistry of Tissues (4) Enzymology, and (5) Biochemistry of Carbohydrates. There are also Laboratories of Physical Chemistry, Analytical Chemistry, Organic Chemistry, and Physiology, each of which has the dual function of supplying needed materials and methods to the principal biochemical divisions and pursuing its own special problems. The several subdivisions in general collaborate and supplement each other in addition to carrying on their own investigations. Each laboratory has its own responsible head. There is an institute library with an especially fine reprint collection. Scientific direction and administration, supplies, and equipment are, of course, centralized under Dr. Parnas.

The following written statement concerning the current work of the Laboratory of Intermediate Nitrogen Metabolism, headed by A. E. Braunstein, a member of the Academy of Medical Sciences, and the Laboratory of Enzymology, under M. G. Kritzmann, may be of interest:

> Braunstein and his colleagues continue the study of the enzyme system and biological significance of the enzymatic transamination of amino acids, discovered in this laboratory. A review of transamination, including a new theory of the integrative functions of dicarboxylic acids in nitrogen metabolism, by Braunstein, will appear in Vol. 3 of *Advances in protein chemistry*. The mechanism of hydrogen translocation in the course of transamination is being studied in isotopic experiments with deuterio-amino acids (Konikova and Braunstein), showing that the labilization and dissociation of α-hydrogen (hydrogen on the α-carbon) is a preliminary and independent enzymatic preliminary step of the reaction. In a cross-assay of the coenzymes of amino acid decarboxylases and transaminating enzymes, made in cooperation with Dr. Gale (Cambridge), the identity of phosphopyridoxal with the prosthetic group of glutamic aminopherase, recently an-

nounced by American authors, has been corroborated, and its non-identity with the "coenzyme" of aspartic aminopherase has been proved (Braunstein and Kritzmann).

A specific enzymatic manometric micromethod for the determination of aspartic acid has been worked out by Braunstein, Nemchinskaya, and Wilenkina. A. S. Konikova made an extensive study of the amino acid metabolism of *Bac. brevis*. An important finding of hers is that *B. brevis* contains large amounts of d-amino acids in the cell proteins as well as in gramicidin and tyrocidine.

The mechanism of the stimulatory effect of ascorbic acid on the metabolism of tyrosine has been investigated in tissue slices by R. Azarkh. The effect is positive in ascorbic acid-deficient and normal guinea pigs and in rats. It is associated with a reaction preceding deamination. Work is in progress on the mechanism of enzymatic synthesis of peptides in animal tissues.

Braunstein is preparing a comprehensive monograph on the biochemistry of amino acid metabolism for publication in Russian and English.

M. Kritzmann has proved that the Wood-Werkman reaction of CO_2-fixation and the transamination reaction are intermediary stages of the synthesis of alanine from NH_3 and pyruvate in liver slices. Phosphate is also involved in this synthesis, which has been effected, for the first time, in cell-free enzyme systems by Kritzmann and Melik-Sarkyssian. Kritzmann has succeeded in the reversible splitting of glutamic aminopherase. The nature of liver aspartic dehydrogenase is being investigated in her laboratory.

The following notes on the functional significance of adenosine triphosphate for the muscular and nervous systems were furnished by Eugene B. Babsky, head of the Physiological Laboratory:

> The work of the laboratory has established the fact that small quantities of adenosine triphosphate heighten the excitability of the muscles and increase muscular contraction. Large quantities of adenosine triphosphate lower the excitability of the muscles and decrease muscular contraction. In small quantities (1×10^{-7}–5×10^{-8}) this substance stimulates tetanic contractions.
>
> The laboratory's experimental data lead us to the conclusion that the release of adenosine triphosphate which occurs with every individual muscular contraction heightens the excitability of the muscles (researches of E. B. Babsky and F. D. Sheikhon).
>
> The laboratory's investigations have also shown that adenosine triphosphate sensitizes muscles to acetylcholine and choline. The interaction of these substances is of importance in the transmission of an impulse from the nerve to the muscle, since when the nervous impulse reaches the muscle acetylcholine is released in the neuro-muscular synapse, and adenosine triphosphate in the muscle.
>
> The substance described by numerous investigators as contained in the tissues of the brain and as acting as a sensitizer to acetylcholine is, according to the data obtained in this laboratory, adenosine triphosphate (researches of E. B. Babsky and P. F. Minayev).
>
> In investigating the influence of adenosine triphosphate taken from the muscles or from the brain, upon electroencephalograms, it has been shown that this substance markedly affects the amplitude and frequency of cerebral potentials. This is a direct indication of the physiologic significance of adenosine triphosphate in the functions of the brain (researches of E. B. Babsky, A. E. Gurvich, and M. N. Livanov).

A third program of special interest was described by S. O. Kaplainsky, head of the Laboratory of Chemistry of Tissues. Studies in this laboratory are concerned with the effects of protein deprivation and wound dystrophy. These have shown that in conditions of extreme deprivation of protein essential enzymes of the tissues may become deficient. The proteins of the deamidizing and decarboxylating systems are thus partially lost. In consequence, nonoxidized keto-acids and nondecarboxylated amino acids are eliminated in the urine. The excretion of amino acids in the urine may be increased three to four times in wound dystrophy. There is decrease in urea excretion due to lack of function of an enzyme in the liver; enzymes in the kidney are less impaired. Changes in the enzyme systems of the brain are also involved; respiration of brain tissue may be decreased two- to threefold. Metabolic detoxification processes may be stopped almost entirely.

The consequences of loss of the proteins of the fermentative systems resemble in some features the avitaminoses due to lack of enzymes for which the deficient vitamins are coenzymes. Some of the observed changes in man seem to be irreversible, even after restoration of normal protein intake, if protein deprivation has been too long continued. The best restorative measures, in the experience of these investigators, are intravenous administration of fresh human plasma and the feeding of liver proteins.

THE STATE CENTRAL MEDICAL LIBRARY

The State Central Medical Library of the Ministry of Health of the USSR, of which L. Bassias is the director, must be mentioned because of its importance as an agency for exchange of literature in the medical sciences between the United States and the USSR. The staff comprises some 140 persons, 138 of whom are women.

Here we found a fine collection of foreign journals, including the best English and American psychiatric and mental hygiene journals, as well as the *Journal of Bacteriology*, *Journal of Immunology*, *Journal of Biological Chemistry*, etc. We were informed that the *Journal of Biological Chemistry* was the most used journal in English. Many books in English were on display, and a whole room was devoted to catalogues of American medical and scientific supply firms. We were told that money to buy books (in English) was now in hand and that their immediate need was for catalogues. Everywhere in stacks and reading rooms there was evidence of intensive use of the facilities available. Both Dr. Bassias and her assistant librarian, Mrs. Maisil, showed great enthusiasm for, and devotion to, their work. They in turn spoke of the heroic girls who had worked in the dark and cold of the library every day during the war, even though a bomb fell through the stacks. In a recent letter to Mrs. Mudd, Dr. Bassias writes:

> We have only just summed up the results of our work for the three quarters of the first postwar year which appear to have surpassed our expectations. They showed that we have outdistanced the achievements of the last prewar year. In 1940, our reading rooms have been visited 60,476 times and 237,884 books have been borrowed from the stacks, while throughout the period from January 1st to October 10th, 1946, 68,371 visits to the reading rooms and 235,914 loans from stacks were already registered. The same increase can be seen in all the branches of our work and not only in our Library but also in other medical libraries of our country.
>
> These figures reflect as in a mirror the intensive, creative work of our medical workers, who strive, as well as all the other people here, to cure as soon as possible the wounds inflicted by war. Nobody in our country derives profit of war. On the contrary, war brings only suffering to all the people and demands heavy sacrifices. It would be so nice if all could understand, as you do, how much happiness we gain from our peaceful work, the results of which we feel so vividly. Work really has become in our country a "matter of honour, valour and heroism," and I suppose this to be the main characteristic feature of Soviet people.

THE FIVE-YEAR PLAN OF THE ACADEMY OF MEDICAL SCIENCES

A comprehensive five-year plan of medical research and its applications was adopted in preliminary form by the Academy of Medical Sciences of the USSR early in September 1946 and was formally adopted in November. This plan, covering 200 mimeographed pages, will appear, when translated, in the *American Review of Soviet Medicine*. The areas of research covered are thus listed in the Table of Contents:

I. Main Problems of Public Health in the Postwar Period: Scientific principles of Soviet public health protection; Medicosanitary consequences of the war and measures for overcoming them; hygienic standards and sanitation of external environment; protection of the health of mother and infant; child health protection; protection of the health of industrial workers; problems of nutrition.

II. Medical Problems Arising From War Traumas: Restoration of functions after war traumas; clinical and pathophysiologic study of traumas of the nervous system and their restorative therapy; biology of infected wounds; traumatic shock; the problems of pain.

III. Problems of Infection in Theory and Practice: Infection and immunity; epidemiology and pathology of infection; malaria, helminthiasis and other problems of medical parasitology; ultraviruses and ultravirus diseases; tuberculosis; problems of scarlatina in child health protection; the problem of sepsis; etiotropic therapy of infectious diseases.

IV. Urgent Problems of Clinical Medicine: The problem of malignant growths; hypertonia; gastric and intestinal ulcers; problems of modern hematology and blood transfusion.

V. Physiologic Regulation and Means of Actively Influencing It: Reactivity of the organism; correlative processes in the organism; regulation of the composition and properties of the internal medium of the organism; pharmacological regulation of functions; the influence of physical factors on the human organism; capacity for work, fatigue and rest.

VI. Physiology and Pathology of Nervous Activity: Factors of integration in the nervous system; the higher nervous activity; psychoses (pathogenesis and therapy).

VII. Certain Problems of Theoretical Medicine: General physiology and pathology of the cell; growth and development of the normal and pathological organism; metabolism and energy; the physiology of digestion; history of medicine.

The secretary of the Academy states that the proposals incorporated in this plan originated with the staffs of the 25 component institutes of the Academy. They were then subject to discussion between the presidium of the Academy and the component institutes. The plan, as finally agreed upon, was adopted by the Academy and returned to the institutes as a recommended but not obligatory program. The emphasis of the plan on fundamental theoretical problems is noteworthy.

Academician A. I. Abrikosov, first vice-president of the Academy of Medical Sciences, in comment upon this five-year plan, has written in part:

> It is to be pointed out that the five-year plan of the USSR Academy of Medical Sciences insures the genuinely scientific synthesis of the various scattered factual findings obtained by scientists, institutes and laboratories in the course of their work on one or another phenomenon. . . .
>
> The essence of our method does not consist in mere registration of phenomena. The task of the Soviet scientist is to explain phenomena and their causal interdependence, to combine theory with practice in relation to man not only as a biological unit but as a social being whose normal and pathological development is affected first and foremost by the social conditions prevailing in his environment (*Moscow News*, November 16, 1946).

Interchange of scientific literature between the United States and the USSR is already established and is growing; the science of both countries is enriched thereby. The sending of reprints, monographs, foundation reports, and book catalogues relating to the medical sciences is one easy and concrete way of promoting intercultural understanding. These may advantageously be mailed to the State Central Medical Library of the Ministry of Health, Sadovo-Kudrinskaja, 1, Moscow, USSR. Good will exists between those scientists of the two countries who have had the opportunity for personal acquaintance. It is the author's earnest belief that the good of both countries demands the future broadening of the basis of mutual understanding and good will.

NEWS *and Notes*

The Executive Committee of the newly-formed Inter-Society Committee for a National Science Foundation has circulated a questionnaire to the delegates of the 70-odd societies which have combined to urge that a National Science Foundation be established in this Congress. The questionnaire is designed to get a vote on the controversial issues, asking specifically about the type of administration preferred, the patent provisions, the inclusion of the social sciences, and the extension of scholarships and fellowships into the undergraduate years. Returns have been received from about 70 per cent of the members. Two-thirds prefer a single administrator as called for in S 525; 20 per cent favor the board type of administration described in S 526; the others prefer a commission form of administration. Practically everyone is willing to accept the S 526 patent provision. Two members voted to exclude the social sciences, and 40 per cent would be willing to accept a Foundation which did exclude them. The final tabulation will become part of the report which will be presented to the Committee on Interstate and Foreign Commerce, now considering the bill in the House, as an extension of the testimony offered on March 6 by Edmund E. Day, president of the Inter-Society Committee.

About People

Arthur E. Meyer, formerly director of research, Maltine Foundation of Therapeutic Research, is now director of the Research Division, Fellows Pharmaceuticals, 26 Christopher Street, New York City.

Theodore H. Eaton, Jr., has been appointed professor of biology at Southwestern College, Winfield, Kansas.

James L. Gamble, professor of pediatrics, Harvard Medical School, delivered the 6th Harvey Lecture of the current series at the New York Academy of Medicine, March 20. He discussed "Physiological Information Gained From Study on the Life Raft Ration."

Willis Robert Boss has been appointed associate professor of zoology at Syracuse University, Syracuse, New York, to begin September 1, 1947. Dr. Boss was formerly at the State University of Iowa and since February has been at State Teachers College, Edinboro, Pennsylvania.

Keith B. McCall, who has just completed work toward the Doctor's degree at the University of Wisconsin, is now instructor in biochemistry at Michigan State College, East Lansing.

Harold F. Blum, who served during the war as principal biophysicist at the Naval Medical Research Institute and spent the past year as a Guggenheim Fellow, has rejoined the staff of the National Cancer Institute to work at the Marine Biological Laboratory, Woods Hole, Massachusetts.

Freeman D. Miller has been appointed associate professor of astronomy and Max Hutt, associate professor of psychology, at the University of Michigan, Ann Harbor, to begin in the fall of 1947.

Hobart E. Stocking, Department of Geology, Oklahoma A. and M. College, has been awarded the title Professor Honorario of the Faculty of Sciences, University of Costa Rica, by Rubén Torres R., dean of the Faculty. Prof. Stocking served as State Department visiting professor at the University during 1945.

B. O. Dodge, plant pathologist, retired from the staff of New York Botanical Garden, December 31. The *Bulletin* of the Torrey Botanical Club is dedicating Volume 74 to him. Dr. Dodge's principal work has been with *Neurospora,* which he holds to be capable of mutating and hybridizing.

Harry Seneca, with the Army until a few months ago and formerly at Tulane University, is now associated with the Clinical Research Division of the Schering Corporation, 120 East 30th Street, New York City.

George K. Bennett, vice-president of The Psychological Corporation, was recently elected president to succeed Paul S. Achilles, who has become vice-chairman of the board of directors. Dr. Bennett joined the Corporation in 1936 as director of the Test Division, and from 1942 to 1945, in addition to his other duties, was in charge of war research. Dr. Achilles has been with the Corporation since 1929 and president since 1944.

Harvey Lincoln Curtis, physicist at the National Bureau of Standards since 1907 and for 32 years chief of the Inductance Capacitance Section, has retired, according to E. U. Condon, director of the Bureau. He is past-president of both the Philosophical Society of Washington and the Washington Academy of Science.

Eric Thomas Stiller, formerly head of the Department of Organic Chemistry, Wyeth Institute of Applied Biochemistry, has been appointed a member of The Squibb Institute for Medical Research, New Brunswick, New Jersey, in charge of the newly-formed Division of Chemical Development.

Atherton M. Whaley has recently been made president of Halogen Chemicals Incorporated, manufacturers of organic halides, Columbia, South Carolina.

John F. Enders, associate professor of bacteriology and immunology, Harvard Medical School, has been appointed director of the Research Department of Infectious Disease of the newly-organized Children's Medical Center, with laboratories at Children's Hospital, Boston, Massachusetts.

Theodor von Brand, formerly professor of biology, Catholic University of America, is now chief of the subsection on physiology, Zoology Laboratory, National Institute of Health.

Colleges and Universities

The Stanford University School of Medicine, San Francisco, California, announces the 65th course of popular medical lectures to be delivered during March and April at Lane Hall, San Francisco. "New Eyes for Old: Corneal Transplants" was discussed by Max Fine March 7; "The War on Cancer," by David A. Wood, L. Henry Garland, and Leonard G. Dobson, is scheduled for March 21; "Delinquency and Mental Health in a Changing World," by Hale F. Shirley, April 11; and "Contagion From Foreign Lands," by Rodney R.

Beard, April 25. The lectures, which are illustrated, are open to the public.

Rockford College, Rockford, Illinois, presented the following scientists at a conference on science, held as part of its centennial celebration February 21–23: Enrico Fermi, professor of physics, University of Chicago, who delivered the Charter Day address; Wendell M. Stanley, Rockefeller Institute for Medical Research; Frank B. Jewett, National Academy of Sciences; Detlev W. Bronk, chairman, National Research Council; Roger Adams, head, Chemistry Department, University of Illinois; Lillian Gilbreth, professor of management, Purdue University; John Torrence Tate, professor of physics, University of Minnesota; Emma Perry Carr, emeritus professor of chemistry, Mount Holyoke College; and Ruth M. Addoms, associate professor of botany, Duke University.

Rockford College was chartered February 25, 1847.

Meetings

A Symposium on Molecular Structure and Spectroscopy will be held at the Mendenhall Laboratory of Physics, The Ohio State University, June 9–14. There will be discussions of the interpretation of molecular spectroscopic data, as well as methods for obtaining such data, and sessions devoted to microwave and Raman spectroscopy. Dormitory rooms will be available. Further information may be obtained from Harald H. Nielsen, Mendenhall Laboratory of Physics, The Ohio State University, Columbus 10, Ohio.

The Midwestern Psychological Association will hold its 19th annual meeting at the Edgewater Beach Hotel, Chicago, May 2–3. Programs will be mailed to members about April 10. The Chicago Psychological Club is sponsor of the meeting, with Edvin Brye, Chicago Teachers College, chairman of the arrangements committee.

Reorganization of the American Institute of Physics and plans for a new semipopular monthly journal have been announced by the Institute.

Effective immediately, the 7,000 members of the five societies—American Physical Society, Optical Society of America, Inc., Acoustical Society of America, Inc., American Association of Physics Teachers, and Society of Rheology—will become members of the Institute, whereas before the Institute had no individual memberships. Provision is also made for associate membership in the Institute, open to others interested in physics.

No change is made in the organization, functions, and activities of the five societies, the announcement, published in *The Review of Scientific Instruments*, said.

Although there will be a new journal, technical journals now published by the Institute and member societies will remain unchanged. The new journal is designed "to foster unity among physicists and their societies, as well as understanding of the contribution and implications of physics."

Lowell Observatory, Flagstaff, Arizona, recently received a gift of the optical parts of a large Schmidt telescope from Roger Lowell Putnam, trustee of the Observatory since 1927. The correction plate of the telescope has a clear aperture of 25 inches and the aperture-to-focus ratio is one to four, the observatory disclosed.

Jose C. Mendiola, director of the laboratory, National Psychopathic Hospital, Mandaluyong, Rizal, Philippine Islands, has written that his workers are in need of recent publications on histopathological technique.

NRC News

A Committee on International Scientific Unions has recently been appointed by the NRC. Keeping itself informed on matters relating to unions and ready to advise and assist American scientists and scientific organizations in their relations to these international bodies, the Committee consists of John A. Fleming, president, International Council of Scientific Unions, chairman; and L. V. Berkner, Marston T. Bogert, Karl K. Darrow, J. H. Dellinger, Joel Stebbins, Marshall H. Stone, Alexander Wetmore, and John K. Wright.

Recent Deaths

Charles L. Stevenson, 80, former professor of chemistry at McGill University, Montreal, and research chemist at the Wilmington plant of E. I. du Pont de Nemours & Company, died in West Long Branch, New Jersey, March 5.

Philip W. Schutz, 38, professor of chemical engineering, University of California, Berkeley, died in Oakland March 7. He was consultant to the Manhattan Engineering District during the war and went to Berkeley to direct the University of California's program in chemical engineering last September.

Sir Halford John Mackinder, 86, English geographer, and holder of the Charles P. Daly Medal of the American Geographical Society of New York, died March 6 in London. One-time professor at the University of London, Sir Halford was also a member of Parliament for 12 years.

Henry M. Pease, 71, first vice-chairman and a director of the International Standard Electric Corporation, and vice-president and director of International Telephone and Telegraph Corporation, died in New York March 6.

Noboru Takahashi, 54, plant breeder on experiment stations in Korea for 21 years under the Japanese, died July 7 in Japan. After graduating from Tokyo Imperial University, he conducted experiments in field crops, particularly rice and soybeans, in Korea from 1919 to 1945, except for years when he took graduate work in the U. S. and Germany. He has contributed generously of plant material to the U. S. Department of Agriculture, according to USDA officials.

Make Plans for—

Midwest Power Conference, March 31-April 2, Palmer House, Chicago.

American Association of Anatomists, annual meeting, April 3–5, Mount Royal Hotel, Montreal, Canada.

The Electrochemical Society, Inc., annual congress, April 9–12, Louisville, Kentucky.

American Chemical Society, spring meeting, April 14–18, Atlantic City, New Jersey.

Institute of Mathematical Statistics, meeting on stochastic processes and noise, April 24–25, New York City.

National Academy of Sciences, annual meeting, April 28–30, Academy Building, Washington, D. C.

TECHNICAL PAPERS

Antiseptic Action of Glycerite of Hydrogen Peroxide on *Mycobacterium tuberculosis* (var. *hominis*)

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In a previous communication, the bactericidal effects of glycerite of hydrogen peroxide on gram-positive and gram-negative bacteria, as measured by the cup-plate technique, were described (*1*). A second report, concerned with oral organisms, demonstrated the solution as extremely bactericidal by both *in vitro* and *in vivo* studies (*4*). The present paper describes the effects of the solution on *Myco. tuberculosis* (var. *hominis*) as measured by laboratory methods, and clinically on patients with tuberculous lesions of the body surface.

The solution consists of hydrogen peroxide (1.5 per cent) as derived from urea peroxide (4 per cent) dissolved in anhydrous glycerol. Although such solutions are relatively stable (*1*), a secondary stabilizing agent, 8-hydroxyquinoline, is present in concentrations of 0.1 per cent.

To obtain a uniform suspension of cells, the organism is grown in Long's broth medium in 22-ml. tubes for 5 days at 37° C. The cultures are placed on a Kahn shaker for 30 minutes and the clumps permitted to settle. The upper portion of the liquid, containing the suspended bacteria, is pipetted into sterile tubes. The organisms from several tubes (usually two or three) are pooled. Of this suspension, 0.5 ml. is inoculated into tubes containing 20 ml. of liquefied, cooled, Long's agar medium. After thorough mixing, the agar is poured into a Petri dish and permitted to solidify. The bacterial content of each plate averages 9,000,000 organisms as determined by plating 1:10,000 and 1:100,000 dilutions of the bacterial suspension in Long's agar.

Penicylinders (porcelain) are placed centrally on the agar and into each is pipetted 0.1 ml. of the solutions to be tested. These consist of glycerite of hydrogen peroxide, in serial dilutions of 0.1, 0.5, 1, 2, and 4 per cent (given as total urea peroxide); phenol, 2, 3, 4, and 5 per cent; penicillin, 10, 50, 100, and 1,000 units; sulfaguanidine, 1 per cent; sulfadiazine, 5 per cent; and sulfamethazine, 10 per cent.

The plates are incubated at 37° C. for 3 days. The zones of inhibition are measured in millimeters from the edge of the cup to the edge of the clear zone. Evidence of either bacteriostasis or bactericidal potency is determined by transfer of pea-sized portions taken from the center to the periphery of the clear zone to slants of Long's agar and to tubes of Long's broth. These are incubated for 14 days at 37° C.

As was expected, penicillin exhibited no measurable effects. Partial inhibition for the entire plate, with apparent clear zones, resulted from exposure to phenol. There was partial inhibition, with no clear zones, when the sulfonamides were used. For all of these solutions, however, the action was one of bacteriostasis, since all samples of transferred agar, by subculture technique demonstrated viable organisms.

For the glycerite of hydrogen peroxide in the 0.5, 1, 2, and 4 per cent concentrations there were clear zones containing no viable organisms; that is, there was bactericidal action. For the 0.1 per cent solution there was a clear zone with bacteriostasis. The average radial measurements were, successively, 5, 13, 17, 20, and 24 mm., repetition demonstrating statistically acceptable equivalent results.

In a separate set of experiments (*3*), a 17-day-old culture of *Myco. tuberculosis*, as grown on Petragnani's medium, was used. Ten-mm. cubes of this medium are cut and immersed in glycerite of 8 per cent hydrogen peroxide (total urea peroxide) for periods of 1, 2, and 24 hours. The cubes containing the bacteria are removed from the antiseptic solution at the end of the specified time, and, in order to counteract the residual peroxide solution, are placed in Brewer's thioglycolate medium for 1 hour. The cubes are then mixed with sterile saline and streaked on Petragnani's medium. A growth-control cube is placed into the thioglycolate medium and the saline and streaked on the same medium.

Following immersion for 1 hour, the cubes demonstrated slight growth visible by the 9th day of subculture. Following immersion for 2 or 24 hours, there was no growth for periods up to 21 days. The growth control showed a moderate growth by the 9th day.

From this it may tentatively be concluded that the solution is probably bactericidal for *Myco. tuberculosis* in periods of about 2 hours and with certainty in periods of more than 1 but less than 24 hours.

Since other substances will act *in vitro* on *Myco. tuberculosis* but are ineffective *in vivo*, clinical experiments were performed with four patients studied by Dr. Joseph Goldberg, of the Essex County Tuberculosis Sanatorium, Danvers, Massachusetts. All demonstrated "cold abscesses," which were positive by smear and culture for *Myco. tuberculosis*. In one patient the sites were multiple, involving the chest, thigh, buttock, and leg. In the remaining three, the chest wall alone was affected. None had responded to previous treatment, and, as is generally known, this condition does not heal spontaneously, and no local measures have so far been effective.

The glycerite of hydrogen peroxide (urea peroxide 4 per cent) was applied as a wet dressing 2–6 times daily. No other treatment was used. All previous treatment is noted as having been without effect. In three patients, the abscesses healed completely; and in the last, who presented multiple lesions and who is still under treatment, the fourth lesion, although greatly diminished in size and obviously healing, shows occasional slight serous discharge. In no patient was there evidence of irritation or allergic reaction for a treatment period which varied from 4 to 11 months. In order to make certain that these were not temporary remissions, one year was permitted to elapse before the clinical report was made, the first patient having healed by February 1945 and the last by November 1945.

It is hoped that this preliminary communication will stimulate further exploration of the treatment of tuberculous lesions with glycerol peroxide solutions.

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Depletion of Vitamin A Reserves in the Livers of Cattle

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In a recent publication (*2*) the writers reported on the depletion of vitamin A reserves in the livers of steers while in the feed lot. One-hundred twenty Hereford steers, about 18 months of age, were taken from native grass pasture and placed on a fattening ration consistent with good feeding practice. Table 1 gives the slaughtering data and the average vitamin A content of the livers. Vitamin A was determined by the method of Davies (*1*).

TABLE 1

Days in the feed lot	No. of animals slaughtered	Vitamin A reserves (μg. vitamin A/gram liver)
0	22	51.4
41	19	23.7
76	20	11.9
119	19	5.3
166	40	1.9

A relationship in the above data has recently been pointed out by Norris Embree, of Distillation Products, Inc. It was mentioned (*2*) that the curve obtained by plotting the data in Table 1 shows a decreasing rate of loss of vitamin A reserves throughout the experimental period. Dr. Embree cited an article by K. C. D. Hickman (*3*), also of Distillation Products, Inc., which appeared while the above publication was in press and in which Dr. Hickman proposed the hypothesis that the rate of depletion of the body reserves of a vitamin are directly proportional to the total reserves of that particular vitamin in the body. Further, when an animal is subjected to vitamin therapy, it should be possible to calculate a period of half adjustment.

To determine the validity of Dr. Hickman's hypothesis, the data in Table 1 were subjected to analysis. Vitamin A reserves were plotted against days in the feed lot and vitamin A values determined at intervals of 40 days. Table 2 gives the values obtained.

TABLE 2

Days in the feed lot	Vitamin A reserves (μg. vitamin A/gram liver)	Drop in 40 days (%)
0	51.4	—
40	24.2	47
80	11.1	46
120	5.2	47
160	2.2	42

It will be observed that the percentage drop in vitamin A reserve in the liver at the end of each 40-day period is practically constant. This supports Dr. Hickman's hypothesis as regards the rate of depletion of body reserves of a vitamin.

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Thromboplastic Properties of Penicillin and Streptomycin

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Moldavsky, Hasselbrook, and Cateno (*6*) have described some interesting findings with the blood of patients receiving parenteral injections of penicillin. In a series of human subjects studies on the clotting of blood before and after administration of penicillin revealed that the clotting time was much shorter after injections of the antibiotic than the normal clotting time was before injection. In connection with a study of blood in hemophilia the present writer and Dr. Marcus Ostro repeated the above observations on normal clinical subjects and confirmed the findings made by Moldavsky and his associates, but, curiously enough, when injections of penicillin were given to two patients suffering from hemophilia, no shortening of coagulation time was produced by the drug (*5*).

Inasmuch as it has been discovered experimentally on animals and confirmed by clinical observations that drugs belonging to the digitaloid group show a definite tendency to promote coagulation of blood (*2*, *3*), and inasmuch as more recently certain widely employed mercurial diuretics have also been found to produce such a thromboplastic effect leading occasionally to fatal thrombotic accidents (*4*), an extensive investigation was undertaken to ascertain the frequency and degree of the thromboplastic effects of penicillin on the blood of higher animals. For this purpose not only the ordinary amorphous penicillin available on the market but also the more recent crystalline sodium salts of penicillin were examined, and, still further, the isolated crystalline penicillin principles as well as the newer antibiotic streptomycin were tested.

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[1] Grateful acknowledgment is made to the Commercial Solvents Corporation and its medical director, Dr. Lawrence Smith, for valuable aid in carrying out this research.

METHOD

Over 200 experiments on blood coagulation were performed. These studies were confined to the clotting of *whole blood* as studied by the original Howell Method or, as it is sometimes known, the Lee and White Method. One cc. of whole blood is drawn and immediately put into a homeopathic vial 1 cm. in diameter, and the clotting time is measured with a stop watch, the end-point being taken when the vial can be inverted without flowing of the blood. The majority of the experiments were made on rabbits and cats; a few were also made with dogs' blood and still others with human patients' blood. In obtaining blood from lower animals, as in the case of rabbits, the samples were drawn by heart puncture. In the case of cats, nembutal anesthesia was first produced and blood drawn either directly from the heart or from the carotid arteries. In making these coagulation studies a good deal of experience is required to avoid complications such as admixture of tissue juices, etc., which may produce abnormal changes in coagulation time.

The earlier studies, begun in the summer of 1945, were made with sodium salts of amorphous penicillin, a dozen or more brands of such penicillin on the market being used. Later, with the development of more reliable therapeutic products, the colorless and more stable crystalline sodium salts of penicillin were employed and compared with the amorphous variety. In these studies the crystalline sodium penicillin of the Commercial Solvents Corporation was used for the most part. Later, through the courtesy of the same concern and also partly by courtesy of Dr. Harry Eagle, of the Johns Hopkins School of Hygiene and Public Health, small quantities of the four crystalline active principles of penicillin were studied separately and in combination with each other. The streptomycin employed in this present work was obtained through the courtesy of Dr. C. S. Keefer, of the Evans Memorial Hospital, Boston.

RESULTS

Amorphous penicillin of every brand examined produced marked acceleration of clotting time, whether injected intravenously or intramuscularly and even when administered by stomach tube mixed with amphogel. The onset of this property can be noted usually within 15 or 20 minutes after injection but in some cases is most marked about one hour after. The effect persists usually for several hours.

When the newly produced sodium salt of crystalline penicillin (C.S.C.) was examined, however, the thromboplastic effect was much less striking. According to the scientists in charge of preparing the crystalline substances, this preparation consists almost entirely of penicillin G. For this reason it was deemed very desirable to secure and examine the comparative effects on coagulation of the four crystalline penicillin principles. Penicillin G (benzyl penicillin) and penicillin F (pentyl penicillin) were much less thromboplastic in their efficiency than penicillins X (hydroxy benzyl penicillin) and K (heptyl penicillin). The most potent in this respect was X. Next in order came K, followed by G and F. It was found, furthermore, that a small dose of penicillin X added to penicillin G produced a synergistic effect and hastened coagulation much more than a large dose of G alone.

Streptomycin was found to be also markedly thromboplastic for blood of rabbits and cats.

DISCUSSION

In the light of these experiments and the results outlined above, there can be no doubt as to the accuracy and importance of the observations first reported by Moldavsky and his associates.

The author was also impressed by the interesting fact that when rabbits were repeatedly used for the above experiments, the coagulation time of those animals was permanently shortened for long periods of time, so that for examination of new preparations fresh animals had to be employed. It was also interesting to learn that this shortening in coagulation time in rabbits and cats could be antagonized and canceled by suitable doses of dicoumarol administered by stomach. It is the opinion of the present writer that, next to the chemotherapeutic properties of penicillin and streptomycin and their low toxicity, the most important pharmacological finding is their thromboplastic activity, which at first impresses the clinician as a very dangerous factor to be considered in their therapeutic use. Fortunately, however, nature has provided such generous checks and balances as well as compensatory and reserve faculties to the higher animals that thrombotic accidents in medical practice after the use of penicillin are extremely rare. Nevertheless, such clinical reports are already cropping up, as, for instance, that by G. Frada (*1*), who reports four patients with embolic accidents attributed by him to increased coagulability of the blood due to penicillin. The complete details of the present research will appear in the *Archives Internationales de Pharmacodynamic et de Therapie.*

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Activity of Protein Synthesis by the Intestine

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In a recent paper (*1*) Bloch reported that the proteins of the intestinal wall of an animal fed arginine labeled with N^{15} had the highest isotope concentration. He advanced two alternate explanations to account for his finding: (1) If the bulk of the absorbed amino acids is carried by the portal vein, arginine enters the internal organs only after passage through the liver, where arginase and the ornithine cycle cause the replacement of the isotopic amidine nitrogen by ordinary nitrogen; thus, the proteins in the liver and those poured out by the liver have a low isotope concentration if compared to the proteins of the intestinal wall. Or (2) the amino acids are utilized while they are being absorbed, and thus the arginine would be incorporated into the protein of the intestinal wall without having been exposed to dilution.

Bloch's first explanation cannot account for the observation that orally administered methionine (labeled with S^{35}) shows the highest incorporation in the proteins of the intestinal mucosa, as reported by Tarver and Schmidt (*2*). Bloch's second explanation was tested in our laboratory by injecting labeled methionine *by way of the jugular vein*. (Bloch administered the amino acid orally.) Again the protein of the intestinal mucosa showed the highest isotope concentration. The same result is obtained when tyrosine (labeled with C^{14}) is injected intravenously.

The interesting finding that the intestinal mucosa has the highest specific activity is explained by us as being due to actual increased protein synthesis rather than to the conditions of the experiment. The intestinal wall secretes enzymes and mucous-proteins which are lost in enormous quantities (unlike other enzymes and proteins within the body). To compensate for this loss the intestinal wall may be more active in protein synthesis than other organs.

If this explanation is correct, then the pancreas should also show a high turnover rate; pancreatic juice contributes many enzymes needed for digestion. Actually Tarver and Schmidt (*2*) found that the pancreas has the second highest specific activity among the organs of animals treated with isotopic methionine.

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Lipoid Substance in the Cells of Proximal Convoluted Tubules of the Kidneys of Young Rats on a Choline-deficient Diet

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Descriptions of the histological changes in the acute "hemorrhagic" kidney of young choline-deficient rats make little, if any, mention of the appearance in frozen sections of any demonstrable fat (*1*). In a series of such sections stained with Sudan IV, from kidneys of rats three to four weeks of age and weighing 35–45 grams, fatty droplets have been consistently observed in the cells of the proximal convoluted tubules. The animals were killed at daily intervals after being placed on a choline-deficient diet. These fatty changes were usually first seen on the third day, but in one instance were observed as early as the second day. The droplets of fat increased in size and number, reaching a maximum on the sixth or seventh day, when congestion, hemorrhage, and cortical necrosis were readily demonstrable.

The appearance of this fat may be secondary to degenerative changes in the tubular epithelium resulting from dietary lack of the lipotropic factor, choline; but the possibility that it may be important in the production of the other lesions of the "hemorrhagic" kidney is being investigated. The fatty droplets are observed before the onset of congestion, necrosis, hemorrhage, or cast formation. It has already been demonstrated (*3*) that the lipase content of the proximal convoluted tubule is diminished or absent in such kidneys. Reduction of the ratio of the phospholipid fraction to the total lipid content has also been established (*2*). Further biochemical and histochemical investigations of the nature of the histologically demonstrable fat are being undertaken to determine its relationship, if any, to the kidney lesions which result from choline deficiency.

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Quick Decline of Orange Trees—A Virus Disease

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Recent results of experimental tests set up in southern California in June 1945 have shown that the highly destructive quick-decline disease of oranges is infectious, and these new results, now viewed in connection with other experiments, indicate that it is a virus disease. Quick decline, known only since 1939, is similar in many respects to the disease known in Brazil as *tristeza*, which, within the last 8 or 9 years, is reported to have almost completely destroyed all orange trees on sour orange root stocks in Argentina and Brazil. The quick-decline disease has been known to occur only on sweet orange varieties on sour orange root stock. Consequently, a test was made with 200 one-year-old healthy Valencia orange trees grown on sour orange stock. Live buds from quick-decline trees were placed in 100 of these healthy trees, and 100 trees were used as checks. Healthy buds were placed in 50 of the latter group, and 50 remained unbudded.

In September 1946 a few trees into which diseased buds had been inserted began to show symptoms. On November 11, 1946, 36 per cent of the trees in which diseased buds had been inserted showed symptoms; only 2 per cent showed disease in each of the two groups of the check trees. Since all these test trees were healthy trees that had originated in a non-diseased area and were planted in a quick-decline area in the open, the 2 per cent was presumably caused by natural infection.

A description of the transmission tests and of many other experiments planned for investigation of other phases of the quick-decline problem will be found in the April, October, and December 1946 numbers of *California Citrograph*. The more detailed evidence on which this preliminary statement is made will appear later.

The great preponderance of diseased trees in the inoculated group as compared with the checks, together with much additional data which indicate that the disease is not due primarily to organisms, nutritional unbalance, or other factors, lead to the definite conclusion that it is of the nature of a virus disease.

A Quantitative Study of the Complement-Hemolysin Relation

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A precise spectrophotometric method employing the end-point of 50 per cent hemolysis (*2*) has been used to measure the changes in complement activity that occur when a standard suspension of sheep's erythrocytes is sensitized with graded amounts of a hemolytic antiserum. Complement was titrated without preliminary incubation, and the 50 per cent units were determined by the method of least squares. The latter were then plotted against the corresponding amounts of antiserum to give the curve of the complement-hemolysin relation (*5*). Analysis of the experimental findings indicated that this curve may be rectified by plotting the ratio x/y, as ordinate, against x, as abscissa, where x represents hemolytic antiserum, and y, the unit of complement. A graph of the results obtained in a representative experience is shown in Fig. 1. In fitting the line

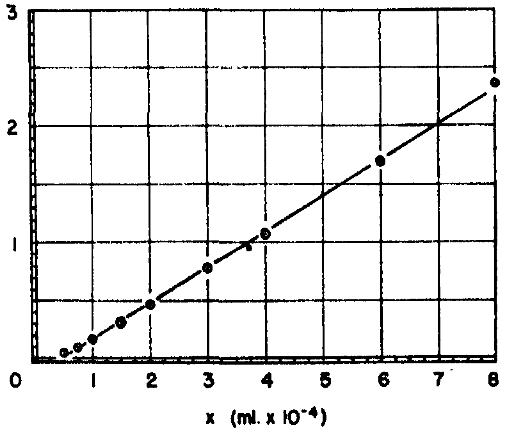

FIG. 1. Graph of x/y vs. x, where x represents hemolytic antiserum; y, the 50 per cent unit of complement.

$$(x/y) = bx + a \qquad (1)$$

to such data, the method of least squares was used to find values of b, the slope, and a, the intercept on the ordinate axis. For the example given, it was found that b = 0.308 and a = −0.137. To test the applicability of Equation 1 to the experimental points, the ratios x/y were calculated by substituting the predetermined values of a and b in the equation and allowing x to take on those used experimentally. The standard deviation of the observed from the calculated ratios was estimated (*3*) from

$$s'^2 = \Sigma\,[(x/y)_{\text{observed}} - (x/y)_{\text{calculated}}]^2/N{-}2. \qquad (2)$$

The estimate, s′ ≌ 0.022, was obtained for the results plotted in Fig. 1.

Solving Equation 1 for y gives

$$y = \frac{x}{bx + a}, \qquad (3)$$

which would express the curve of the complement-hemolysin relation. Vertical and horizontal asymptotes of this curve are demonstrable (*1a*), respectively, at

$$x = \frac{-a}{b} \text{ and } y = \frac{1}{b}.$$

If the axes are translated to a new origin at the point $(\frac{-a}{b}, \frac{1}{b})$, the equation assumes the standard form for a rectangular hyperbola referred to its asymptotes as axes (*1b*).

Curves based upon Equation 3 have fitted the experimental points over a wide range of hemolysin quantities but deviate somewhat when low concentrations of the reagent are used.[2] It is of interest that the highest concentrations employed failed to produce an inhibition of complement activity such as has been ascribed to agglutination of erythrocytes by concentrated antiserum. Such inhibitions have, nevertheless, been observed occasionally in previous experiments, and Equation 3 would not be expected to express the complement-hemolysin relation in the affected range.

TABLE 1

EFFECT OF HEMOLYSIN CONCENTRATION UPON THE CONSTANT, 1/n, IN VON KROGH'S ALTERNATION FORMULA

x Hemolytic antiserum (ml. × 10^{-4})	0.50	0.75	1.0	1.5	2.0	3.0	4.0	6.0	8.0
y 50% unit of complement (ml. × 10^{-3}) (calculated*)	29.41	7.98	5.85	4.62	4.18	3.81	3.65	3.51	3.44
1/n........ ..	0.366	0.354	0.254	0.221	0.199	0.175	0.166	0.180	0.189
Complement required for 99% hemolysis (ml. × 10^{-3}) (calculated†)......			18.79	12.76	10.43	8.51	7.83	8.03	8.20

* Values of y from Equation 3, where b = 0.308 and a = −0.137.
† From the Von Krogh formula (*4*).

The data were also examined with regard to the effect of hemolysin concentration upon the slope of the hemolytic curve. The parametric constant, $1/n$, in Von Krogh's alternation formula (*4*) was taken as the index of slope, and its values were determined, by the method of least squares, at the same time as those of the 50 per cent units of complement (*2*). It was observed that $1/n$ approaches a minimum in a central range of hemolysin concentration and increases progressively with the use of greater or lesser amounts of the reagent. Table 1 gives the values obtained in the experience illustrated by Fig. 1. More pronounced increases of the slope parameter were observed in the presence of concentrated hemolysin when antisera of higher titer were tested.

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[1] With the technical assistance of Helen M. Conway and Willie Mae Bodie.

[2] As a result of consultations with W. R. Thompson, of the Division of Laboratories and Research, New York State Department of Health, it appears that a better fit may be obtained with the more general form of rectangular hyperbola, $(x - x_0)(y - y_0) = k$, where x_0, y_0, and k are parametric constants. The application of this formula will be discussed in a more comprehensive report.

In an attempt to estimate the influence of this variable in determining the least quantity of complement which may safely be used in complement-fixation tests, the amounts of complement which would be required for 99 per cent hemolysis were calculated from the Von Krogh formula by substituting the predetermined values of $1/n$ and the 50 per cent units of complement. Estimates obtained in this manner are included in Table 1. In general, the concentration of hemolysin requiring a minimum amount of complement for 99 per cent hemolysis corresponded closely with that exhibiting a minimum value of $1/n$. It is noteworthy that both minima were observed in the range of hemolysin concentration which has been taken as optimal for the complement-fixation reaction (*5*).

The application of the foregoing criteria in the standardization of hemolysin is being studied. Equation 3 would permit the objective definition of an optimal concentration for complement-fixation tests.

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Reduction in the Vital Capacity of Asthmatic Subjects Following Exposure to Aerosolized Pollen Extracts

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The difficulty of determining the allergic factors responsible for asthmatic attacks is well recognized. Skin tests are frequently of little value for two reasons: first, because intense reactions in the skin may be produced by extracts of pollens or other substances which apparently are not factors in the production of the asthmatic attacks; and second, because many individuals with asthma do not show skin reactions to allergenic extracts.

A new approach to the study of asthma and the problem of determining the specific causes of asthmatic attacks was suggested by the demonstration that in the great majority of asthmatic subjects a reduction in vital capacity follows the parenteral administration of histamine or mecholyl (*1*). In the study to be described here, these changes in vital capacity were observed to follow inhalation of one or more extracts of birch, oak, grass, and ragweed pollens and certain other substances in 6 or 7 asthmatic subjects studied. Exposure to the aerosol was obtained by 15 or less deep inhalations of aerosolized extract from a small hand nebulizer attached to a tube with oxygen flowing at a rate of 6 l./minute. The nebulizer was held in front of the open mouth of the subject during the inhalations. Aerosols of the extracting fluid used in the preparation of the allergenic extracts failed to produce changes in vital capacity. Reductions to as little as 60 per cent of the control values have been produced by the pollen extracts, and in no instance has there been any associated reaction other than cough, a tight feeling in the chest, and symptoms of hay fever. These sensations were, according to statements made by the patients, identical with spontaneously occurring attacks of hay fever or asthma. Physical signs of asthma appeared with the more marked reductions in vital capacity but were never striking with the dosages used.

In those instances in which a reduction in the vital capacity followed inhalation of an aerosolized extract, the maximum decrease usually occurred between 6 and 10 minutes after exposure. In all patients but one the vital capacity returned to the control value within 50 minutes.

We have no reason to doubt the reliability of this method of testing for specific factors in asthma. In the patients studied to date, substances which produced a fall in vital capacity have always been of clinical significance as judged by the patients' histories and skin tests. Nevertheless, sufficient data to determine the value of the test in diagnosis are not available at the present time. Substances which were suspected of being clinically important have not always produced a fall in vital capacity. Furthermore, the method is time consuming, requires the cooperation of the patient, and is hampered at the present time by the lack of any accurate means of measuring the intensity of the exposure to the aerosol. Although cough and severe symptoms of hay fever may follow exposure to an aerosolized extract and may interfere with the measurement of the vital capacity, this has not been frequent in our experience, even when a marked decrease in vital capacity occurred. As such symptoms are clearly allergic in origin, their appearance may be helpful in diagnosis.

In spite of the disadvantages mentioned above the method appears to be very promising for the following reasons: (1) Reductions in vital capacity can be safely induced in the laboratory in asthmatic subjects by substances known to be capable of producing asthmatic attacks; (2) the lung, the chief site of the disease process, serves as the test organ; (3) the effect of various drugs in preventing or modifying changes in vital capacity following exposure to aerosolized extracts can be readily studied; and (4) the method affords an objective test in many instances because a considerable decrease in the vital capacity may occur without awareness on the part of the subject that a reaction to the inhaled extract is taking place.

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IN THE LABORATORY

A Method for Reclaiming Dried Zoological Specimens

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In most zoological laboratories alcoholic specimens which have dried out are discarded, regardless of their original significance. Material of distinct taxonomic value and critical specimens on which distribution records are based are often included in the losses to which laboratory collections are exposed, in spite of improved types of containers and systematic replacement of preservatives. Various methods have in the past been suggested as a means of reclaiming and at least partially restoring accidentally dried specimens. Potassium hydroxide and lactic acid are two reagents which have been used with some success on certain kinds of dried specimens, especially on some arthropods and nematodes. Both of these chemicals have definite limits to their usefulness, however. Caustic potash has the very real disadvantage of destroying tissues.

In this laboratory it was discovered a few years ago that commercial grade of trisodium phosphate in aqueous solution alters the permeability of membranes of preserved specimens of various invertebrates. This chemical has been of great value in treating specimens of parasitic worms to ensure free passage of fluids through the body wall when permanent whole mounts are being prepared. It has been observed that specimens which have become hardened and somewhat shriveled in the preserving medium become softened and pliable in trisodium phosphate. The specimens also become somewhat plumped but show no evidence of unnatural swelling. Furthermore, treatment with this chemical does not destroy the internal tissues. It thus has a very distinct advantage over caustic potash.

The highly satisfactory results obtained from the use of trisodium phosphate on small objects suggested the possibility of using this detergent for recovery of larger specimens which had become useless through drying. In numerous preliminary tests various kinds of dried animals have been subjected to the action of trisodium phosphate, and in most instances the results have been extremely gratifying. The results are not uniform for all kinds of dried specimens treated, but in every instance the reclaimed specimens showed restoration of general body form and revealed details of diagnostic characters which had been wholly unavailable in the dried specimens and in those treated with water or alcohol alone.

Trisodium phosphate becomes effective on dried specimens at low concentrations. A very dilute solution working for a long time seemed to be as satisfactory as a stronger solution for a shorter period. In routine procedure, quantities of the chemical were not measured, but it was later found that 0.25 to 0.5 per cent of commercial trisodium phosphate in distilled water was effective in restoring the appearance of specimens treated. Warmed solutions were more rapid in their action than cold. In many instances, with small or originally delicate objects, the maximum effect was obtained in about one hour, although longer treatment continued to soften tissues and make the specimens more pliable. Some leeches that had been dry for several years were placed in trisodium phosphate in an oven at 35°C. After about an hour most of the external features had been restored to normal appearance, and after two days the leeches were relatively soft and pliable without showing any evidence of dissociation of the tissues.

Insect nymphs and delicate crustaceans which had been completely dried out in storage vials were restored to conditions wherein all characters needed for classification were observable. Dried centipedes and millipedes had all the shriveled appendages restored to condition fully available for identification. A preserved sample of fresh-water plankton which had been dry in a bottle for more than two years was covered with warmed trisodium phosphate. Less than one hour thereafter five species of cladocerans, two species of copepods, and several species of shelled rhizopods were all readily determinable.

A small minnow infected by a large liguloid tapeworm had dried to badly shriveled condition and chalky whiteness. Treatment with trisodium phosphate restored general external appearance of the fish, and the coils of the cestode were readily observable through its body wall.

Many other discarded objects have been reclaimed by this simple process. Perhaps the most striking example is a collection of relatively large nematodes which had been dry for many years. Some of these worms were reclaimed while the others were left dry for comparison. Samples of the reclaimed specimens were stained and mounted by the usual procedure for making microscopic mounts. These show details of buccal armature, form and structure of the esophagus and pharynx, and details of the uterine coils.

Vacuum Infiltration as a Method for Determining Enzymic Activity *in Vivo*

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The usual method for the study of enzymes is to extract them from macerated tissues and observe their activity in a controlled medium outside living cells. Shortly before the war there appeared in Russian literature a description of a method for the determination of the activity of enzymes inside living cells. This was based on the vacuum infiltration of living cells with an enzymic substrate and on subsequent determination of what is left of it after a period of time. In the original method living tissues were infiltrated with a solution of either invert sugars or sucrose, and the rates of sucrose synthesis or hydrolysis were determined (*1*). Later on this was extended for the determination of the activity of phosphatases (*6*) and also for the synthetic activity of proteases (*3*). In the hands of Russian investigators these methods, and particularly the original one, have proved to be useful tools in several fields of physiological investigations. It was thought, therefore, that a brief description of the method itself, together with a few results obtained so far, might be of interest to workers on this continent.

The technique of the original method is as follows: Three comparable samples of leaves are placed separately in 150-cc. beakers. One sample is covered with distilled water and serves as a control. The second sample is covered with a 0.1 M solution of sucrose, and the third with a 0.2 M solution of invert sugars. The beakers are placed in a desiccator and evacuated down to 20–40 mm. of pressure. When the stream of air bubbles from the leaves has ceased, the air pressure is slowly brought to normal, and the leaves become infiltrated with the surrounding solution. They are then removed from the solution, dried, left for a few hours at room temperature, and at the end of this period analyzed for their sugar content. From the difference between the sucrose contents of leaves infiltrated with invert sugars and of those infiltrated with distilled water, one obtains the amounts of sucrose synthetized in leaves during this period of time. In a similar manner, the difference between the invert sugar contents of leaves infiltrated with sucrose and of those infiltrated with distilled water gives the value for the amounts of sucrose hydrolyzed.

A sample of calculations follows. Leaf samples were infiltrated with distilled water, invert sugars, and sucrose and, three hours after infiltration, were analyzed for various forms of sugar. The results of the analysis are given in Table 1.

TABLE 1

SUGAR CONTENT OF LEAF SAMPLES EXPRESSED AS MG. OF GLUCOSE/1 GRAM OF LEAF DRY WEIGHT

	Invert sugars	Sucrose	Total sugars
(1) Control	32.8	18.4	51.2
(2) Infiltrated with 0.2 M invert sugars	125.0	35.6	160.6
(3) Infiltrated with 0 1 M sucrose	67.2	97.3	164.5

Invert sugars in the amount of 109.4 mg. were infiltrated into Sample 2, and 113.3 mg. of sucrose into Sample 3. In Sample 2, 17.2 mg. (35.6 − 18.4) of sucrose, or 15.7 per cent of the amounts introduced, were synthetized. In Sample 3, 34.4 mg. (67.2 − 32.8) of sucrose, or 30.5 per cent of the amounts introduced, were hydrolyzed. Calculated per hour per gram dry weight of leaf tissues, these rates become 5.7 mg. of sucrose synthesis and 11.5 mg. of sucrose hydrolysis. The synthesis: hydrolysis ratio of 5.7: 11.5 indicates a considerable excess of hydrolysis over synthesis.

It was found that in a given plant organ the synthesis: hydrolysis ratio does not remain constant but undergoes a series of diurnal and ontogenetic changes. Thus, it was reported that in the leaves of sugar beets (*12*) and in *Bromus* (*9*) this ratio increases in the forenoon, comes to a peak at noon, and then declines. This ratio is high in a young leaf and declines in an old one (*14*). Vernalization decreases the ratio in the leaves of both wheat and cotton and causes it to approach that of plants in more advanced stages of their development (*3*). In ripening fruits there is at first a short rise in the ratio, followed by a decline as a consequence of a considerable increase in hydrolysis and a drop in synthesis. These changes are accelerated by the ethylene treatment (*5*). In late varieties of plants the synthesis:hydrolysis ratio is higher than in the early ones (*3*, *10*, *11*, *13*). When in different varieties of onion bulbs, beet roots, and watermelon fruits the ratio is high, a greater proportion of their sugars is present in the form of sucrose (*10*).

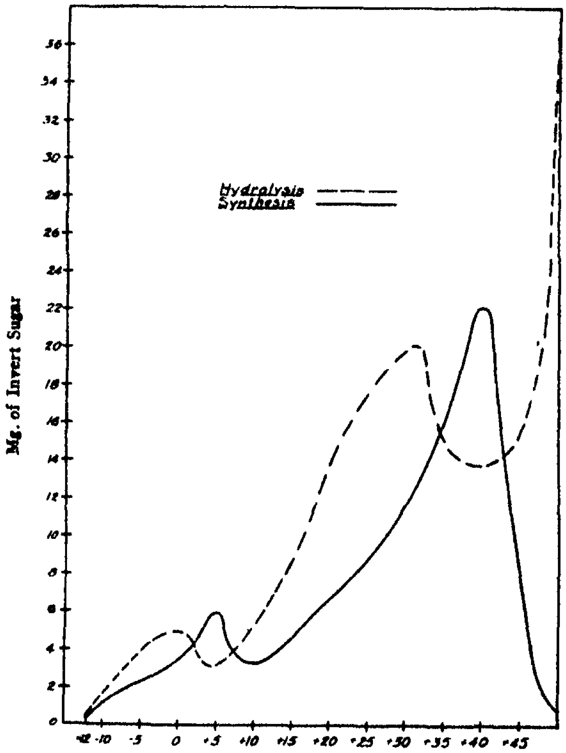

FIG. 1. Effect of temperature on the synthesis and hydrolysis in 25-day-old seedlings of winter rye. (Figure from paper by A. Kursanov, N. Krjukova, and A. Morozov, *8*.)

The effects of inorganic constituents on the enzymic activity within the living cells can be studied by either infiltration of tissues with such constituents or by using plants grown on deficient media. It was observed that the deficiency of phosphorus decreases the synthetic capacity of sugar beets (*14*) and chicory leaves (*16*). Simultaneously, the per cent of reducing sugars in the total sugar fraction is increased. The presence of potash was reported to stimulate synthesis in a number of plants (*4*, *18*). On the other hand, NaCl and $CaCl_2$ depress synthesis (*18*).

By keeping the leaf samples after their infiltration at different temperatures, the effects of this last factor were studied (*8*). The results obtained are shown in Fig. 1. From an examination of the figure it is seen that at the middle range of temperatures there is a direct relation between temperature and either synthesis or hydrolysis. At both high and low temperature extremes there are, however, two short ranges of temperature, when the rates of synthesis are above those of hydrolysis. When a hardier and a frost-susceptible variety of Cinchona tree were placed for a short time at 0° C., there was a decrease in the absolute rates of both synthesis and hydrolysis in the leaves of both varieties. On return to a higher temperature with a hardy variety, this decline was found to be a reversible one, and this variety recovered. With a frost-susceptible variety the decline was found to be an irreversible one, and the plant died (*7*). On the strength of such experiments it was suggested that a low-temperature injury or even death in a plant may be a result of interference with the normal functioning of its enzymic mechanism. That a low-temperature injury may occur above 0° C. supports this contention.

The effects of decreasing water content of leaves on synthesis and hydrolysis were determined in wilting tea leaves (*2*).

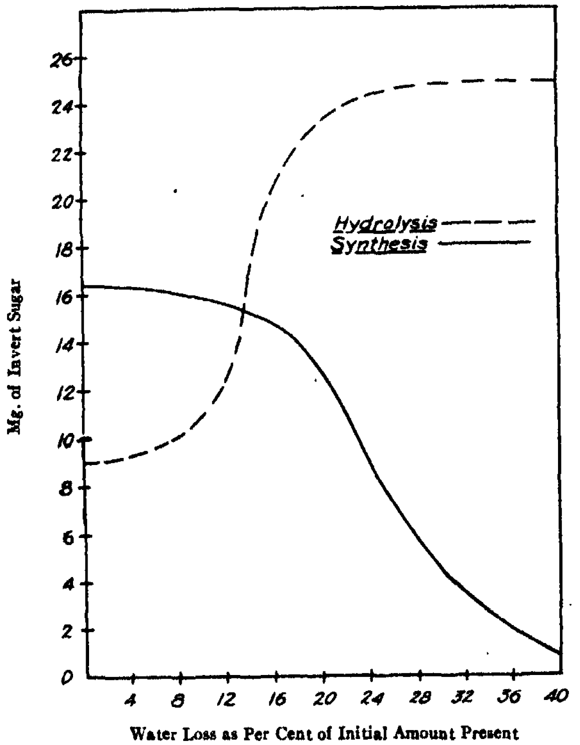

FIG. 2. Effect of water deficit on the synthesis and hydrolysis in tea leaves. (Figure from paper by A. Kursanov, *2*.)

Fig. 2 gives the data obtained. It is seen that a decrease in the water content of leaves results in a decrease in synthesis and an increase in hydrolysis. The two graphs are approximately mirror images of one another. Though the initial synthesis: hydrolysis ratio is higher in the leaves of drought-susceptible than in those of the resistant varieties of wheat, under the conditions of wilting this ratio drops off more rapidly in the former varieties than in the latter (*15*). The same was reported for the synthetic and hydrolytic action of proteases (*17*). It was suggested that the absolute value of this ratio, and the rate of its fall under the conditions of wilting, may be used in diagnosis of drought-resistant and nonresistant varieties of plants. This could be done even on plants which are in their seedling stage.

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Action of Subtilin in Reducing Infection by a Seed-borne Pathogen

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Previous studies (*2*) at this laboratory have indicated that infection by certain seed-borne pathogens may be reduced by the antibiotic action of the natural microflora of the soil. More recently attention has been concentrated on individual antagonists from the soil, especially on those showing evidence of producing antibiotic substances capable of preventing seed-borne pathogens from producing infection. A survey for such organisms in Alberta soils, conducted in collaboration with A. W. Jackson, resulted in the selection of *Bacillus subtilis* Cohn, emend. Prazmowski, as a promising antagonist. It proved to be particularly active in culture against *Xanthomonas translucens* (J. J. and R.) Dowson, a seed-borne bacterial pathogen which we had under observation. Moreover, subtilin, a known antibiotic substance (*3*) produced by *B. subtilis*, was found in plate tests to be active against *X. translucens*. Hence, this substance was chosen for the special study reported here, which has to do with the effects of subtilin on *X. translucens* and, in turn, on the disease which it produces in barley.[1]

The sample of subtilin used was kindly supplied by the Western Regional Research Laboratory of Albany, California, at the request of the National Research Council of Canada. A pathogenic strain of *X. translucens f. sp. cerealis* (*1*) was provided by W. A. F. Hagborg, of the Dominion Laboratory of Plant Pathology, Winnipeg. O.A.C. 21 barley was employed

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[1] Financial assistance from the National Research Council of Canada is gratefully acknowledged.

as the host plant of the pathogen, and difficulties at first experienced in infecting it by means of seed-borne inoculum were largely overcome by the use of a modification of Wallin's (*4*) technique.

By making up the infestation medium with dilutions of subtilin in distilled water it was possible to infest seed with *X. translucens cerealis* and treat it with subtilin simultaneously. The seed was treated under partial vacuum for 1 hour and then allowed to soak in the medium for 20–24 hours. Preliminary experiments had shown that subtilin had no injurious effect on seed when applied in this way. The treated seed was then sown in 6-inch flower pots containing a 1:1 mixture of Edmonton black soil and fine sand. Twenty-five seeds were sown per pot and 200 seeds were used per treatment. One series was sown in steam-sterilized soil and another series in unsterilized soil. The pots were kept at 30° C. in constant-temperature chambers in the greenhouse for 10 days, after which notes were taken on emergence and on the number of lesioned plants. The results are presented in Table 1. The pots were then left on a greenhouse bench for 10 days longer and a second count then made. No increase in emergence occurred in the sterile series, but there was some increase in the unsterile series. The second disease count gave results comparable to the first.

TABLE 1

EFFECT OF DIFFERENT DILUTIONS OF SUBTILIN ON THE ABILITY OF *X. translucens cerealis* TO INFECT BARLEY SEEDLINGS

X. translucens cerealis in a dilution of:	Sterilized soil			Unsterilized soil		
	No. plants emerged	No. showing lesions	Diseased* (%)	No. emerged	No. lesioned	Diseased* (%)
1:1,000 subtilin	120	1	0.8	46	0	0.0
1:3,000 "	127	39	30.7	44	3	6.8
1:5,000 "	124	52	41.9	59	15	25.4
Sterile dist. H_2O	83	39	47.0	49	10	20.4

* $\frac{\text{No. of seedlings showing lesions}}{\text{No. of seedlings emerged}} \times 100.$

It will be noted from the above table that *X. translucens cerealis* exposed to a 1:1,000 dilution of subtilin was largely inactivated as measured by its ability to cause infection in barley seedlings. Comparable infection trends were obtained in sterilized and unsterilized soil. The consistently lower percentages of infection in the unsterilized as compared with the sterilized soil are probably attributable to the antibiotic action of the natural soil microflora, as has been reported for certain diseases of flax (*2*). The natural soil microflora is probably also responsible for the low degree of emergence in the unsterilized series, since the seed was sown in a soaked condition and kept at 30° C., which would make it quite susceptible to such action. The infection ratings in the test were based on the number of seedlings emerged. It has been shown by Wallin (*4*) and confirmed by our experiments that *X. translucens* causes a reduction in emergence of barley. Had our infection ratings taken reduced emergence into consideration, they would have been still more striking.

The results of the above experiment show that subtilin is effective in reducing infection of barley by *X. translucens cerealis* when applied as indicated at the time of infestation of the seed. It is desirable to know whether it can destroy inoculum applied to the seed before as well as at the time of treatment. Other experiments at this laboratory had shown that seed artificially infested with *X. translucens cerealis* and then dried would still produce infection when sown. Accordingly, seed was artificially infested with *X. translucens cerealis* alone and then dried for 4–5 days at room temperature. This pre-infested seed was then treated with 1:1,000 subtilin by two methods: (1) under partial vacuum for 1 hour and then allowed to soak in the solution for 20–24 hours, and (2) under partial vacuum for 15 minutes. The seed thus prepared, together with an untreated check, was then sown at the rate of 350 seeds per treatment in a 1:1 sterilized soil and sand mixture and kept at 30° C. in constant-temperature cabinets in the greenhouse. Emergence and disease counts, taken 7 days later, are presented in Table 2.

TABLE 2

EFFECT OF TREATING BARLEY SEED, ARTIFICIALLY INOCULATED WITH *X. translucens cerealis*, WITH A 1:1,000 DILUTION OF SUBTILIN

Treatment	Seedlings emerged	Seedlings lesioned	Diseased (%)	Emergence (%)
Vacuum, 1 hr.; soaked, 20–24 hrs.	165	29	17.6	47.1
Vacuum, 15 min.	261	90	34.5	74.6
Check	249	103	41.4	71.1

These results show that subtilin will act to reduce infection when applied to seed artificially infested with *X. translucens cerealis* before treatment. The low emergence in the first treatment is probably due to the effect of the two rather severe vacuum treatments, one during the infestation and the other in the application of subtilin.

It is not implied that the results here reported are immediately applicable in the practical treatment of seed. However, they do indicate that seed treatment with antibiotics may, with future refinements of technique, have some possibilities of a practical nature.

The methods used here would seem to provide results that are more reliable for assessing the practical value of antibiotic substances to be used against seed-borne bacterial pathogens than are those obtainable from plate tests. Limitations of materials have so far prevented the use of other methods of determining the practical value of subtilin in relation to the treatment of seed.

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Book Reviews

Human genetics. Vols. I and II. Reginald Ruggles Gates. New York: Macmillan, 1946. Vol. I: Pp. xvi + 742; Vol. II: Pp. vi + 743–1518. (Illustrated.) $15.00 per set.

Prior to the publication of these two volumes there existed no truly comprehensive reference work dealing with the subject of human inheritance. Except for the genetics of the human eye, skin, blood groups, twinning, and a few other topics, where more extensive summaries are available, *Human genetics* provides the most complete compilation now available on many aspects of human heredity.

The first four chapters cover a general ground: "Introduction," "General Principles of Heredity in Man," "Human Cytology," and "Linkage." The remainder deal with abnormalities of the various organ systems, with normal or anthropological variations, and with special topics, such as allergy, cancer, constitution and disease susceptibility, mental defect, syndromes, metabolic errors, normal mental differences, etc.

In considering the merits of Dr. Gates's work, one must keep in mind some of the peculiarities of the study with which he is concerned.

There is, first, the enormity of the subject. Man is an extremely variable species, and this variability has been recorded in a medical and biological literature of gigantic proportions. An illustration may be of interest. In his chapter on abnormalities of the eye, the author summarizes the literature on approximately 100 hereditary anomalies. One of these (Marfan's syndrome) is associated with skeletal changes and is described in another chapter, where references are made to 25 papers. A recent review article on this syndrome cites 192 publications.

The literature is not only large but elusive, for human heredity has remained largely an incidental study, and titles of medical papers frequently give no clue to their genetic contents. The extensive bibliography therefore makes this a most useful work, and this feature has been well done. The lists of references apportioned to the 31 chapters cover 243 pages and provide complete title and page citations. There is also a very full index of 90 pages.

Since most medical texts contain rather meager references to heredity, the chapters on pathological inheritance will doubtless prove of greater value than the others. Here the medical specialist may find convenient summaries on the genetics of such everyday problems as hypertension, dental caries, breech presentation, or susceptibility to poliomyelitis, or equally, of such oddities as the Marcus-Gunn phenomenon, auricular appendages, or Pelger's leucocyte anomaly.

For the most part, the text consists of an unbroken series of abstracts of papers and citations of pedigrees. Wherever possible, the author calls attention to problems of genetic physiology, and he incorporates a valuable feature in the frequent reviews of certain hereditary abnormalities in animals which resemble those of man. However, the inadequacies of the data bearing on many problems in human genetics have tempted the author to speculate quite freely on modes of inheritance, linkage relationships, rates of selection, mutation, etc. The following excerpts occur in the chapter on albinism.

"Complete albinism appears to be found in all races, perhaps represented by the same gene. But the frequency of this gene varies greatly, from perhaps 7 per 1000 in the San Blas Indians of Darien to 5 per 1000 in the Hopi Indians, 1 per 10,000 in Norway, 1 in 29,000 in Italy and 1 in 100,000 in France and Russia. This may depend on differences in the mutation frequency, but as to the causes of such differences there is no evidence at the present time. That they exist must, however, have some evolutionary significance. It supports the general view (Gates, 1936) that differences in mutation rates arise within a species or group of related species. . . . There may be a greater frequency of albinism in very fair families but albinos also arise from parents with dark brown or black hair. Possibly blond hair is genetically linked with the gene for albinism. . . . From these and other records it is clear that albinos of the colored races generally have more iris pigment than albinos of the white race. They are probably recessive in inheritance, but in the light of Zimmermann's records some of them might be dominant. They are by no means a uniform group but probably a series of alleles, some of them illustrating how the white race arose from colored ancestors."

In the figures cited, the incidence of albinism is incorrectly described as the frequency of the recessive gene, while the remainder of the passage reveals a mixture of uncritical review and surmise, which characterizes many sections of the text. By repeatedly offering genetic linkage as an explanation for genetic correlations of all kinds, the author perpetuates a widespread misconception that these two terms are synonymous. His chapter on linkage contains no clear explanation of autosomal linkage or examples of its statistical detection, but there is appended a list of 48 "probable or possible" autosomal linkages, which in most cases are based on statements similar to the above.

There is, indeed, a conspicuous dearth of quantitative reasoning and statistical method throughout, a lack which seems particularly unfortunate in any treatise on human heredity. For such a work is likely to be consulted by many who are unfamiliar with the usual requirements of statistical analysis in genetics, let alone the more complicated procedures which are made necessary by the peculiarities of human data.

Human genetics is, thus, a descriptive account of a science which is still largely in the descriptive phase of its development. The chief value of these two volumes lies in their comprehensive treatment of a vast and little-summarised literature. They encourage the student to think about problems in cytology, physiology, and population genetics, but in the last-mentioned field, they provide him with no better guide than that of conjecture.

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Cosmic Radiation and Cancer

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THE FACT THAT THE TOTAL ENERGY received by the earth as cosmic radiation is no greater than that of starlight has led many to assume that this could have little, if any, biological effect. Other considerations would indicate, however, that even radiation of such low intensity may have an influence on so-called spontaneous mutations and genetic effects in general. One must admit that these effects may occur with any amount of radiation, and even though the probability decreases with lower intensities, it must be remembered that all living things receive a continuous exposure throughout life. The term "lifetime exposure" is somewhat indefinite in this instance, since protoplasm is passed from one generation to another, and the biological effects of such low-intensity radiation may be additive over a period of several generations.

The theoretical speculations which have emphasized the low intensity and ignored or minimized the possibility of biological effects have probably served only to inhibit the search for such effects. There appears to be a need for less speculation and more experimental testing. This is especially true in the field of cancer research for, in spite of the attractive nature of such investigations, the writer was unable to find a single reference involving the experimental evaluation of the possible influence of cosmic radiation on carcinogenesis. The technical difficulties involved in evaluating such an omnipresent factor may also have had a deterrent influence, for in order to obtain conclusive data on the influence which cosmic radiation may have in regulating cancer incidence, it would be necessary to study the induction of cancer with various agents in an environment free from cosmic radiation. This would require a chamber with lead roof at least 49 feet thick or laboratory space 700 feet underground. Since the former was regarded as impractical and the latter was impossible with the funds available, a simple substitute procedure was devised.

It was hoped that the results of this preliminary experiment would indicate whether it would be worth while to investigate this problem more extensively. The experiment[1] involved the attempt to intensify cosmic radiation effects by means of various combinations of lead plates and the comparison of the rate of carcinogenesis in mice receiving the intensified cosmic radiation with the rate of carcinogenesis in mice receiving non-intensified (normal) cosmic radiation. The rate of induction of cancer in the mice kept under the lead plates was found to be consistently and definitely higher than that in the controls.

One hundred and eighty-four male mice[2] of the C$_3$H strain were injected with 0.25 mg. of methylcholanthrene in sesame oil and distributed equally in 8 aluminum cages, 11 x 11 x 4 inches. They were given food and water ad libitum.

Lead plates ¼ inch thick were placed over 5 of the 8 cages. Lead of this thickness was chosen because it had been shown by other investigators (*3*) that the optimum thickness for the production of small cosmic radiation showers was 0.6 cm. while the optimum thickness for the production of large showers was approximately 2 cm. Four of the cages were, therefore, covered with only one sheet of lead while two lead sheets were placed over the fifth. Cage 1, without a lead plate, and Cage 2, with one lead plate, were placed on the top shelf of a metal rack on the fifth floor of a six-story concrete steel building. Cages 3 and 4, a similar pair, were placed on the top shelf of a metal rack on the first floor of the same building. Cages 5 and 6, with one lead plate on each, were arranged on the second and third shelves from the top of the rack vertically below Cage 4. Cage 7, with two lead-plate covers, was placed vertically below Cages 4, 5, and 6. Cage 8, without a lead cover, was placed 4 inches south of Cage 7 and vertically below Cage 3. Cage 8, although not vertically below Cages 4 and 5, was near enough to have received some scattered cosmic ray showers from the lead plates over the latter cages. It was also beneath three iron shelves of the rack. No data could be found on cosmic ray showers in iron, but these probably would occur. Both of these unanticipated circumstances would, theoretically, have had a tendency to increase the intensity of cosmic radiation in control Cage 8 as compared to that in the other two control cages (1 and 3), which were on the top shelves. The metal shelves were painted on each side of the cages so that the position of the cages was maintained relatively constant throughout the 5-month period of observation.

The results were tabulated (see Table 1) using the method of Shimkin and Andervont (*2*). It will be noted that 5 cages contained one or two mice less than 23. In these instances, the mice died or disappeared before the eighth week and were not included in the tabulation. The mice in the three control cages without lead plates are placed together in the table. The numbers in vertical columns below the time in weeks represent the number of new tumors found at each weekly examination. It is apparent that the tumors in the controls developed at a slower rate than in the mice covered with lead plates. It may also be noted that in the lead-plate-covered cages a relatively large number of tumors was recorded on the earliest week tabulated. With a dose of 0.25 mg. of methylcholanthrene, one would expect the first tumor to appear at the seventh or eighth week. It is, therefore, unfortunate that the weekly examinations were not started at an earlier date, because it seems probable that some of the tumors listed under the sixth week may have been palpable earlier. Even with this handicap, the average latent period for the lead-plate-covered mice was only 8.5 weeks as compared with 11.3 weeks for the controls. The 50 per cent latent period—the average latent period for the first 50 per cent of the animals to develop tumors—was 9.6 for the controls and 6.7 weeks for the lead-plate-covered mice.

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[1] This work was supported by grants from the Anna Fuller Fund and the Donner Foundation.

[2] These mice were progeny of mice obtained from L. C. Strong, of New Haven, Connecticut, several years ago.

In experiments of this kind, where practically all the animals eventually develop tumors, one is not concerned with the percentage of animals developing tumors but primarily with the rate of tumor development as expressed in average latent periods.

Only 2 of the 67 controls and 1 of the 111 lead-covered mice did not develop tumors within the period of 22 weeks. These mice had to be excluded from data on the average latent period calculations. However, the carcinogenic index, derived from a formula suggested by Iball (*1*), takes these animals into account. Iball's formula is $\frac{p}{t} \times 100$, where p is the per cent of mice developing tumors and t is the average latent period of the whole group in days. Higher numbers thus indicate more potent carcinogenic stimuli. The index for the control group was 123, while for the lead-plate-covered animals it was 168.

None of these calculations or sets of numbers appears to do justice to the acceleration of the rate of tumor formation which was observed in the early part of the experiment. The remarkable difference between controls and experimental animals which was apparent early in the experiment is indicated by the total number of mice with tumors in each cage at the end of 10 weeks. Control Cage 8 contained 10 mice with tumors at this time. The lowest number of tumors in any of the lead-plate-covered cages was 14. Cage 8, however, was the control cage beneath three metal shelves and may have received scattered cosmic radiation showers from the lead over Cages 4 and 5. Even with the inclusion of this cage in the calculations at the end of 10 weeks, only 22 or 33 per cent of the 66 control mice had developed tumors while 75 per cent of the 110 lead-covered mice had developed tumors which grew progressively larger.

It was of interest that the highest percentage of tumors occurred in Cage 7, which was covered with two lead plates instead of one and placed beneath three iron shelves and three other cages with lead-plate covers. Twenty-one of the 23, or 91 per cent, of the mice in this cage had developed tumors within 10 weeks. The thickness of lead directly over this cage was near the optimum for the production of larger cosmic ray showers. However, the total thickness of lead above the cage (5 cm.) was greater than the optimum. The cages had been arranged in this way in the hope of detecting a possible protective effect due to absorption, but, obviously, such an effect was not observed.

This remarkable increase in the rate of tumor induction brought about by placing lead plates 3 inches above methylcholanthrene-injected mice was thought to

TABLE 1

INFLUENCE OF LEAD-PLATE CAGE COVERS (INCREASED COSMIC RADIATION INTENSITY) ON RATE OF INDUCTION OF PALPABLE SUBCUTANEOUS TUMORS IN C_3H MALE MICE INJECTED WITH 0.25 MG. 20-METHYLCHOLANTHRENE

Cage	Lead plate	No. of mice	No. of tumors per week and time (wks.)																Non-tumor	No. tumors	Avg. latent period (wks.)	50% latent period	Carcinogenic index	Tumors (10 wks.)
			6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21						
1	0	22			1	1	2	6	6	2	3	1							0	22	11.7	10.5	123	4
3	0	22		1	3	1	2	1	5	2	4							1	2	20	11.7	9.5	111	8
8	0	23		1	4	1	4	5	5	2	1								0	23	10.6	9.	135	10
Total.....		67		2	8	3	8	12	16	6	8	1						1	2	65	11.3	9.6	123	22
2	1	22	7	4	3	2	2	3		1									0	22	8.1	6.4	177	18
4	1	22	4	4	2	2	2	2	3	2						1			0	22	9.5	7.	151	14
5	1	21	1	6	6	0	1	4	2	1									0	21	8.9	7.3	161	14
6	1	23	6	4	4	1	2	4	1	1									0	23	8.4	6.5	166	17
7	2	23	6	5	8	1	1	1											1	22	7.5	6.5	181	21
Total ...		111	24	23	23	6	8	14	6	5						1			1	110	8.5	6.7	168	84

be related to the intensification of the cosmic radiation which results from the production of showers or bursts of ionizing radiations which occur when cosmic rays pass through thin sheets of metal. According to this hypothesis, carcinogenic substances such as methylcholanthrene induce cancer by converting some of the energy of cosmic radiation into carcinogenic stimuli; in other words, they sensitize the tissues to this kind of energy. It should be emphasized, however, that these experiments are only preliminary and that conclusive data can be derived only from experiments carried out in the absence of cosmic and other types of radiation.

If this general hypothesis continues to receive verification in future experiments, we may then begin to speculate on how to reduce the incidence of cancer by minimizing the effect of such radiation. The first reaction to such an hypothesis is that, if true, it would be futile to attempt to prevent cancer, because cosmic radiation cannot be avoided. In the first place, it may not be impossible to minimize the life exposure of such radiations by regulating building materials and other environmental factors which may modify the effective intensity of such radiation. Secondly, it has not been the intention of the writer to give the impression that cosmic radiation is the only factor involved in carcinogenesis. Other factors, such as the heavy metals and chemicals within tissues that absorb and modify such radiation, may thus offer possibilities for nullifying the effect of such radiations. Further, the radiation sensitivities of cells of the same and different individuals must vary within wide limits. It is possible that the variation in this respect controls the age at which cancer develops. As the life expectancy of a population increases, more and more people survive long enough to have their least resistant cells undergo malignant transformation as a result of the cumulative and additive effect of cosmic and other similar radiations. In addition to the increased length of the exposure time, we may be increasing the intensity factor by spending a high proportion of our life in buildings beneath roofs and other materials which serve to produce cosmic radiation showers and thus intensify the radiation effects. According to the results of this experiment, an individual whose least resistant cells could stand 50 years of unaltered radiation would conceivably develop cancer at 40 years or earlier if most of the lifetime had been spent in a building which served to intensify cosmic radiation. There are doubtless many other factors that would offer avenues of attack and investigation.

It is most important at present, however, to test this hypothesis further in a conclusive way by repeating these experiments in an environment free from cosmic radiation. Plans to do this are in progress. The prospect of a general exposure of large numbers of people to radiations of this type as a result of developments in the atomic energy field and the consequent popularization of the use of radioactive material provides an added incentive for hastening the investigation. It would seem in order to re-examine qualitatively and quantitatively the question of what is a safe dose of radiation. This should be determined not only for what we call normal cells but also for the occasional extremely radiation-sensitive cell and on the basis of a lifetime exposure.

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Does Patent Consciousness Interfere With Cooperation Between Industrial and University Research Laboratories?

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General Electric Company, Schenectady, New York

ALTHOUGH OUR PATENT SYSTEM IS among the older of our national institutions, there still appear to be misunderstandings concerning it which are not confined to the less educated portion of our public.

A recent meeting of scientists brought forth an implied criticism of our patent system in the statement, which seemed to meet acceptance with many, that overconcern for patents caused many industrialists to draw an iron curtain around their research laboratories, thereby excluding from their research staffs the visits of other scientists and preventing the mutually helpful interchange of information and the stimulating exchange of ideas which are vital to the rapid progress of scientific knowledge.

In every occupation of mankind there are shortsighted individuals, and there may be some industrialists who would prefer to confine their research men in an ivory tower, but it is strange that such a policy should be blamed on the very institution which makes such a policy needless and foolish.

If we had no patent system, then indeed it would be necessary for an industrialist, if he had a research laboratory, to make the hard choice between free scientific exchange, with the practical certainty of frequent and immediate financial loss, and scientific isolation, with the long-range certainty of ultimate sterility. Or perhaps he might attempt a compromise, with the probability of incurring both kinds of loss. Under such conditions, probably very few companies would start or long maintain a research laboratory. It would need a farsighted, courageous, and patriotic industrialist with a long pocketbook to undertake research under such conditions. Such a man, fully realizing that in the long run industrial progress is dependent on scientific research, and that, if there were no industrial research in this country, his whole industry and his company along with it would suffer mortally from competition of other countries where industrial research conditions were more favorable, would decide that he must support some research, even in the face of certain immediate loss in domestic competition.

Our patent system obviates the necessity for such hard decisions. It makes it possible to operate a research laboratory with doors wide open to the stimulating visits of outside scientists, without loss and with the great benefit of the mutual fertilization of ideas which such visits produce.

Patenting an invention protects the inventor or his employer from the gratuitous pirating of its benefits by others. If others wish to share in those benefits, they may be made to share in its cost, through reasonable royalty payments. The effect on the research man in industry is that he is free to welcome fellow scientists from universities or other industrial laboratories, exchange information with them, discuss experiments, compare ideas, and argue on theoretical matters.

The prime function of a research laboratory is to seek new scientific facts. A newly-discovered fact may suggest a patentable application or new material, but the invention is incidental to the scientific work which claims the research man's main interest and which is not patentable. If there were no patent system, not even that scientific work could be freely discussed with fellow scientists for their mere presence in the laboratory would involve possible loss, through their observing and disclosing, quite possibly in all innocence, to its competitors practical developments in progress in the laboratory. Without a patent system, the only safeguard for discovery and its practical applications would be complete secrecy. Furthermore, no industrial research laboratory could safely welcome visitors or send its men to meetings of scientific societies except in the role of sponges, permitted only to absorb in silence.

With our patent system the industrial scientist may enjoy all the freedom to give and take which is possessed by his peers in the universities. The only restraint on his tongue or pen is that, if his work suggests a possible patentable practical application, his first disclosure should be to his patent attorney; and, if the latter thinks a patent application advisable, reasonable time should be given to prepare the necessary papers before further disclosure is made. If he observes this trifling and temporary restraint, the industrial scientist may enjoy to the full his intercourse with his fellows, free and unconstrained, and the institution he serves may reap the undoubted benefit such intercourse yields.

A few industrialists and possibly a very few directors of research may not even yet be fully awake to the opportunity of free scientific exchange in safety which our patent system makes possible. The increasing frequency of exchange of visits between industrial laboratories, as well as between these and the universities, shows that the number of those who have not yet seen the light is small and is growing smaller. As concerns those few, to blame the patent system rather than their individual blindness for their shortsighted policy is surely an error.

No human institution is perfect, and our patent system is a human institution. Indeed the advisory committee appointed by President Roosevelt has recommended certain minor changes in it, which informed opinion quite generally believes might be adopted with advantage by Congress, but the basic principles of that system the committee found to be sound.

Their finding seems supported by the record. With that system in force, our Nation has achieved the greatest fertility in invention and the greatest industrial progress the world has yet seen. Many a small manufacturer, protected by his patent, has built up a highly prosperous business with some meritorious specialty. Manufacturers large and small, to the number of over 2,500, relying on the patent protection they could obtain for applications of research, have founded and are profitably operating research laboratories and thereby helping in the advancement of their industries, the national economy, and scientific knowledge. As for the scientist himself, if he wishes to take advantage of the facilities offered by an industrial laboratory for research in his special field of interest and if he finds that he may do so with no sacrifice of his precious privilege of free discussion with his fellow scientists, whatever their associations may be, he should give thanks where thanks are due—to our patent system.

Theory of Reactions of Cells to Goitrogenic Thiopyrimidines

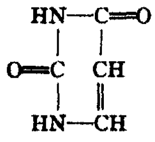
Louis Laufer and Earl D. Stewart
Schwarz Laboratories, Inc., New York City

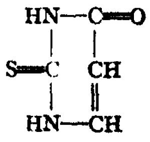
CERTAIN SULFANILAMIDES, as well as thiourea and its derivatives, have been found by Astwood (*1*) to be effective in the treatment of hyperthyroidism. One of the most potent of these derivatives is thiouracil (II). Clinical tests (*7*) on more than 1,000 patients have proved its curative value. In about 10 per cent of the patients, however, toxic reactions such as skin rashes, urticaria, fever, agranulocytosis, and leukopenia occur in the first five weeks of treatment and, as a result, a number of deaths due to the administration of thiouracil have been reported. Thiothymine (IV), or 5-methyl thiouracil, has also been tested (*10*) on rats and clinically, and found to be less effective than thiouracil in cases of thyrotoxicosis.

Reports by Astwood (*2*) and by Leys (*4*) have shown that alkyl substitution in the 6-position of the pyrimidine yields products which are as active, or more active, than thiouracil without any toxic reactions appearing in clinical tests. Thus, 6-normal propyl thiouracil (VI) (*2*) is about 11 times as active as thiouracil. Miller, *et al.* (*6*) showed that thiopyrimidines react with several equivalents of iodine, supporting the hypothesis that these compounds may prevent thyroid hormone synthesis in the gland by blocking the iodination of hormone precursors. They also state that these compounds may decrease iodine liberation by action on the appropriate oxidative enzymes and suggest this also as an explanation for the antithyroid action of the sulfa drugs.

We would like to go somewhat further in explaining the action of the mercaptopyrimidines, basing the explanation on the available evidence. We would postulate that thiouracil and thiothymine, in addition to reacting with iodine, act as antivitamins or antibiotics. The term "antibiotic" is used here somewhat more generally than may be customary, for lack of a better way of expressing the effect of any agent whose presence interferes with or prevents normal cell proliferation *in vivo*. The cells may be those of microorganisms foreign or injurious to the host, or cells of the body tissues or circulatory system of the host proper.

Snell and Mitchell (*8*) have proved uracil to be an essential metabolite for the growth of microorganisms, very strongly suggesting vitamin action. Similarly, thymine (*9*) can partially replace folic acid as an essential nutrilite for lactic acid bacteria. The structural similarities of uracil (I) and thiouracil (II) and of thymine (III) and thiothymine (IV) are shown below.


(I)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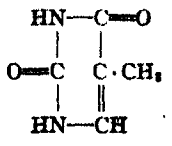
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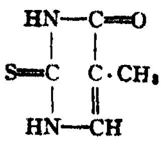
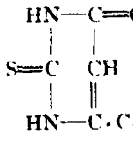
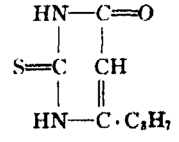

(IV)

The conversion of a vitamin or an essential nutrilite to an antivitamin or antibiotic by alteration of the chemical structure of the vitamins has been demonstrated by Woods (*11*) for para-aminobenzoic acid and sulfanilamide; by Woolley and White (*12*) for 2-methyl-4-amino-5-pyrimidylmethyl-(2-methyl-3-hydroxyethyl) pyridium bromide and vitamin B_1; and by McIlwain (*5*) for pyridine-3-sulfonic acid and nicotinic acid.

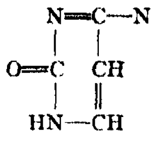
The toxic reactions of thiouracil and thiothymine *in vivo*, especially the incidence of agranulocytosis and leukopenia, bear a marked resemblance in this respect to the toxic action of sulfanilamide, another antivitamin (*11*). Apparently, with some individuals these drugs interfere with the normal metabolism of certain body cells such as leucocytes, and even those occurring in the thyroid gland (*6*).

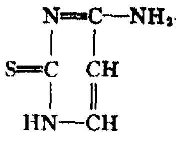
It would seem as if a competition for thiouracil and thiothymine between iodine and other compounds which normally react with uracil and thymine occurs *in vivo*. This is borne out by the fact that 6-ethyl thiouracil (V) and 6-normal propyl thiouracil (VI) (*2*) are 8 and 11 times more effective, respectively, than equivalent amounts of thiouracil and exhibit no toxic reactions when tested clinically. Evidently these two mercaptopyrimidines have had their chemical structure sufficiently altered to react wholly with iodine, hence showing only a goitrogenic action and no antibiotic tendency.


(V)


(VI)

It is of interest to note that uracil occurs only in ribonucleic acid and thymine only in thymus nucleic acid. Both nucleic acids occur in normal cells; thymus nucleic acid, only in cell nuclei; ribonucleic acid, in both nucleus and cytoplasm. A pyrimidine which occurs in both nucleic acids is cytosine. It might be predicted, therefore, that while thiocytosine (VIII), structurally analogous to cytosine (VII), would exhibit antithyroid action, it might also be more toxic or show greater antivitamin action than either thiouracil or thiothymine, because structurally it is analogous to cytosine, a building block in not only one but two fundamental cell components.


(VII)


(VIII)

While these mercaptopyrimidines have been tested *in vivo*, no study has been made to assess their value as antivitamins with microorganisms. Hitchings, *et al.* (*3*) report one test at low concentration on the effect of thiothymine on *L. casei* with inconclusive results.

A thorough study of the action of thiouracil, thiothymine, and especially thiocytosine on a variety of microorganisms including pathogenic forms might be of interest not only to see if antivitamin or antibiotic activity is a characteristic of these sulfur-bearing pyrimidines, but also to obtain evidence of the importance of the normal oxycompounds to cell metabolism. Such a study might also reveal in mercaptopyrimidines and their homologues and derivatives a new class of compounds with antiseptic properties for external use.

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Section E (Geology and Geography) is planning to schedule sessions at the Chicago meeting of the AAAS, on Friday and Saturday, December 26 and 27. Several special sessions are now in the planning stage. Any suggestions concerning the section program should be sent to G. W. White, secretary, Section E, Orton Hall, Ohio State University, Columbus 10, Ohio. Titles of papers offered for presentation at the meeting should be sent to the secretary by May 1, except for papers now being arranged by the various symposium organizers.

NEWS *and Notes*

During the week past the Inter-Society Committee for a National Science Foundation announced the results of a survey of the representatives of the 70-odd scientific and educational organizations that constitute the members. Questions were directed to four of the controversial issues: type of administration, inclusion of the social sciences, inclusion of undergraduate fellowships, and patent provisions. The fifth controversy over the mandatory geographical distribution of funds was not included in the questionnaire.

Two-thirds of the respondents favored a single administrator; 18 per cent favored a Foundation made up of a large number of people; and 18 per cent favored the commission type of administration.

Ninety-eight per cent of the respondents favored the inclusion of the social sciences, either by specific mention or by the permissive provisions of S. 526 and the corresponding House bills. A large majority believed that undergraduate scholarships should be granted, 86 per cent voting in favor of this provision. Ninety-four per cent of the respondents believed that no special stand should be taken on patent legislation.

Certain other questions were designed to find out what compromise, if any, would be acceptable to scientists. The vote was:

Willing to accept a Commission if necessary, 95 per cent.

Willing to accept a single Administrator if necessary, 88 per cent.

Willing to accept a 48-man Foundation if necessary, 86 per cent.

Willing to accept permissive inclusion of social sciences, 99 per cent.

Willing to accept specific inclusion of social sciences, 94 per cent.

Willing to accept exclusion of social sciences, 37 per cent.

These percentages are based on a return of 73 per cent.

It would appear that the opinion of American scientists with regard to the best bills establishing a National Science Foundation would be made up of a combination of those now before the Congress. The language of S. 526 in connection with the inclusion of the social sciences, the provision for undergraduate fellowships, and the patent provisions would seem to be satisfactory, while the single administrator provided in S. 525 is preferred.

Clyde Kluckhohn, Department of Anthropology, Harvard University, has been awarded the $10,000 prize in the Whittlesey House-*Science Illustrated* Contest to encourage publication of scientific books for general readers. Dr. Kluckhohn's book, *Anthropology and the world today*, will be published during the coming year, as will five other books put under contract as a result of the contest. These five contestants will receive $1,000 each as an advance against standard royalties in order that they may complete their projects.

Manuscripts did not have to be complete to be entered in the contest, which closed November 1, 1946. An outline and 10,000 words were required at that time, and the completed book, ranging in length from 80,000 to 150,000 words, must be finished not later than November 1, 1947. More than 250 outlines and sample chapters were submitted.

The purpose of the prize-winning book, *Anthropology and the world today*, is to make plain the varying goals and interrelations of the branches of anthropology and demonstrate how anthropology has been useful in practical ways.

Following are additional books receiving honorable mention:

Men out of Asia, by Harold S. Gladwin, a discussion of the origin of the American Indian in which the author argues for migration from a common Asiatic source via previously existing land bridges, as against the view of independent evolution.

You and your doctor, by Benjamin F. Miller, which attempts to acquaint the layman with the problems of the general practitioner.

Mendelyeev, by Daniel Q. Posin, a biography of the formulator of the Periodic Table in chemistry and an outstanding Russian scientist of the 19th Century.

Whom the gods love, by Leopold Infeld, a biography of Evariste Galois, extraordinary child mathematician.

Causes of catastrophe, by L. Don Leet, which tells cause and effect of forces that shake the earth's crust with explanations of the geological processes involved.

Judges of the contest were Harlow Shapley, director of the Harvard College Observatory and president of AAAS; Waldemar Kaempffert, science editor, *New York Times*; Donald Culross Peattie, naturalist; and Gerald Wendt, managing editor, *Science Illustrated.*

Whittlesey House and *Science Illustrated* are member organizations of McGraw-Hill Book Company, Inc., whose president, Curtis Benjamin, made the awards on March 14. Mr. Benjamin also announced that Dr. Kluckhohn had made a gift of $2,500 from his prize to Harvard University for research on the Navaho.

In a letter to President Truman, dated March 24, the Federation of American Scientists has urged that none of the Germany military scientists imported by the Army be given civilian employment or other privileges, and that they be returned to Germany as soon as possible.

W. A. Higinbotham, executive secretary of the Federation, stated that an inquiry to the War Department had brought a reply that, so far as citizenship is concerned, the German scientists will "in general" be subject to the usual immigration regulations. He added that a State Department spokesman had assured him that the war scientists are here as aliens in military custody, and will have to leave this country and apply for citizenship through the usual quota channels if they wish to be naturalized.

The full text of the statement by the Federation of American Scientists follows:

Dear Mr. President:

In press releases on September 13 and December 4, 1946, the War Department announced that, for the past year, it had been bringing into the United States key German scientists to act as consultants to various military research projects. The releases indicated that this program is to be extended, and that plans exist whereby some former enemy technical personnel will be permitted to accept positions in private industry and educational institutions upon completion of their present assignments. The possibility also was mentioned that the privilege of citizenship might be extended to certain of these individuals.

The Federation of American Scientists wishes to express to you its deep concern over the implications of this War Department program. Certainly not wishing to jeopardize the legitimate needs of national defense, and not advocating a policy of hatred and vengeance toward our former enemies, we nevertheless believe that, during this critical post-war period of national and international adjustment, wholesale importation of scientists is not in keeping with the best objectives of American domestic and foreign policy. We believe that the high positions of trust and responsibility occupied by these individuals in the Third Reich demonstrate that they were either sympathetic with Nazi aims or, at the very least, acquiescent in them.

Any favor extended to such individuals, even for military reasons, represents an affront to the people of all countries who so recently fought beside us, to the refugees whose lives were shattered by Nazism, to our unfortunate scientific colleagues of formerly occupied lands, and to all of those others who suffered under the yoke these men helped to forge. It is not fitting that those who abetted tyranny should find a haven in free America to which the victims may not attain, that we should accept former enemies while barring those who were, and are our allies.

We therefore respectfully urge that the use of Nazi scientists by the armed forces be held to an absolute minimum, that none of them be granted citizenship, that none of them be given employment in industrial or academic installations, and that all of them be sent back to Germany as soon as possible.

Visitors to U.S.

H. B. G. Casimir, co-director of the Philips Research Laboratories, Eindhoven, Holland, arrived in the United States this month to deliver a series of invitation lectures at Johns Hopkins University, Baltimore, on properties of matter at low temperatures and on problems in quantum electrodynamics. Dr. Casimir, who joined the staff of Philips Research Laboratories in 1942, has been directing the assembly of a cyclotron at an independent laboratory in Amsterdam by Philips in cooperation with the Dutch Government.

Corneille Heymans, professor of pharmacology, University of Ghent, Belgium, will spend May and June in the United States as guest of the American Medical Association. Dr. Heymans, Nobel Prize winner, will attend the AMA centennial meeting in Atlantic City and the meetings of the Federation of American Societies for Experimental Biology in Chicago in May.

Grants and Awards

Syracuse University College of Applied Science, Syracuse, New York, has been awarded $46,000 in government contracts for industrial research. The Syracuse study, under Ralph E. Montonna, director of the College's Institute of Industrial Research, and B. J. Lazan, chief of the Materials Testing Laboratory, will follow two paths. A study of temperature-resistant materials is being sponsored by the AAF with a grant of $27,000, and the Office of Naval Research has allocated $19,000 for testing the abilities of materials and structures to absorb vibrational energy.

The Cyrus M. Warren Fund of the American Academy of Arts and Sciences announces availability of grants-in-aid of research in chemistry or closely related fields. Applications for the grants of $300 or less, usually awarded for apparatus, supplies, or construction of special facilities needed in research, should be received by Frederick G. Keyes, Massachusetts Institute of Technology, Cambridge, Massachusetts, not later than April 15.

Fellowships

The Bermuda Biological Station for Research has received a grant of $6,000 from the American Philosophical Society to be used for research fellowships at the Bermuda Station, 1947–49. Applications should be forwarded to Dugald E. S. Brown, director, Biological Station, St. George's, Bermuda.

During the next few years the scientific program of the Station will be centered around the physiology of marine organisms. To this end laboratories of physiology, biochemistry, and biophysics are being constructed and adequate facilities provided for the collection and maintenance of a wide variety of marine organisms. When reconstruction is completed, 17 laboratories will be available to investigators and several rooms for workers not requiring laboratory facilities. By June of this year there will be living accommodations for 24 workers.

Colleges and Universities

The University of Texas Department of Zoölogy announces appointment of the following staff members whose terms began last September: Clarence P. Oliver, University of Minnesota, professor; W. Frank Blair, University of Michigan, assistant professor; Lemuel A. Fraser, University of Wisconsin, instructor; and John M. Cairns, Washington University, St. Louis, instructor. Michael J. D. White, University of London, England, has been appointed professor of zoology to begin September 1947.

Washington and Lee University, Lexington, Virginia, announces that Marcellus Henry Stow has been appointed professor of geology and Lucius J. Desha, professor of chemistry, under the Thomas Ball Foundation professorships recently established. The Foundation was established through a gift of Mrs. Alfred I. du Pont, Wilmington, Delaware, in connection with the University's bicentennial program as a memorial to her father, Capt. Thomas Ball.

Dr. Stow served as deputy director of the Mining Division, War Production Board, during a wartime leave of absence, and before returning to the University this session was chief of the Mining Branch of the Civilian Production Administration.

Dr. Desha was professor of biochemistry at the University of Tennessee College of Medicine before going to Washington and Lee. He is currently acting dean of the latter University.

The University of Utrecht, Netherlands, has announced the following changes in science professorships since the liberation: new appointments—J. B. L. Hol, physical geography; J. F. Reith, pharmacy; D. van Dantzig, mathematics; J. W. M. Milatz, physics; G. J. van Oordt, zoology; and S. W. Visser, meteorology; retired—N. Schoorl, pharmacy; K. Oestreich, physical geography; J. A. Barrau, mathematics; E. van Everdingen, meteorology; deceased—L. S. Ornstein, physics; H. J. Jordan, animal physiology; W. C. de Graaff, pharmacy; L. M. R. Rutten, paleontology; and J. Wolff, mathematics.

The Polytechnic Institute of Brooklyn, New York, has announced the 6th and 7th symposia in a series of eight on "Recent Progress in the Field of High Polymers," to be held in the student lounge of the Institute, 99 Livingston Street, Brooklyn.

"Advances in Physical and Organic Chemistry of Cellulose" will be discussed March 29 by the following: Eugene Pacsu, Princeton University; H. J. Philipp, Celanese Corporation of America, and E. W. Roseveare, E. I. du Pont de Nemours & Company.

"Mechanism of Polymerization" will be discussed April 19 by W. H. Melville, University of Aberdeen, Scotland; W. B. Reynolds, Philipps Petroleum Company; M. G. Evans, University of Leeds, England; G. Goldfinger, University of Buffalo; and A. G. Evans, University of Manchester, England.

Western Reserve University recently received a grant of $70,000 from the Cleveland Foundation for continuation of work on disease prevention and for research on infectious diseases by the Elisabeth Severance Prentiss Department of Preventive Medicine, founded in 1945.

The Department is organizing and equipping a large laboratory for research on influenza, common cold, pneumonia, and some common childhood diseases. The laboratory will occupy half of the third floor of the School of Medicine building on the campus.

The Department is also working closely with the Cleveland Division of Health and other health agencies, as well as the staffs of university and city hospitals, on a program of preventive medicine.

Last summer five members of the Commission on Acute Respiratory Diseases in the U. S. Army Epidemiological Board joined the Department, with John H. Dingle, director of the Commission, Elisabeth Severance professor of preventive medicine. Work done by these men in the Army is being continued at the University.

The University of Illinois has recently acquired the parasitology library of the late Henry Baldwin Ward. Some 15,000 volumes have been purchased for $15,000, and the Ward family has given as a Ward Memorial a reprint library of between 35,000 and 40,000 items.

Meetings

The Pacific Division of AAAS will hold its 28th annual meeting in San Diego, California, June 16–21, with headquarters in the U. S. Grant Hotel.

The address of Thomas G. Thompson, president of the Pacific Division, will be Tuesday evening, June 17, on the subject, "Research." George L. Clarke, Harvard University, will discuss "Light and Life Within the Sea," June 18, and Lee A. DuBridge, president of the California Institute of Technology, "Radar and Its Peacetime Uses," June 19.

Excursions have been planned to Los Coronados Islands, Mt. Palomar, Borego Valley, and the Salton Sea.

General communications may be addressed to the chairman of the local general committee, R. Dana Russell, U. S. Navy Electronics Laboratory, San Diego. Correspondence about exhibits should be sent to Ormus L. Doolittle, Engineering Department, Southern California Telephone Company, San Diego 1.

The New York State Geological Association will hold its 19th field meeting at the College of the City of New York, May 9–10, 1947, year of the C.C.N.Y. centennial celebration. Reservations may be made through Cecil H. Kindle, Department of Geology, City College, New York 31.

Ten Swedish astronomers and geodesists will go to South America and five or six to Africa to study the solar eclipse on May 20. By means of exact timing of the eclipse an accurate determination of the distance between the two continents will be attempted, the Swedish-International Press Bureau states. The African group will probably be stationed north of the town of Accra on the Gold Coast, and the South American group at the Brazilian town of Araxá.

Astronomers from the United States, Brazil, Argentina, England, and New Zealand will observe the eclipse from Brazil and Argentina (*Science*, February 28).

Parcels have been sent to over 1,000 families of needy European scientists through the activities of a Committee of U. S. Scientists' Wives during the past year (*Science*, May 10, 1946). Packages have been sent to 400–500 Dutch, 210 Czech, 75 Polish, 100 Belgian, and 50 Greek families, as well as others in Finland, France, Norway, and Italy, the Committee reports. Many Poles, Czechs, Greeks, and others still need shoes, warm clothing, and foods, however. Names of needy families may be obtained from Grace H. Smith, National Bureau of Standards, Washington 25, D. C.

The Committee of Scientists' Wives has transmitted an appeal for Greek scientists by W. Edwards Deming, Bureau of the Budget, who recently returned from Athens. He pointed out that civil service assistants at the Laboratory of Astronomy and National Observatory in Athens, as well as the astronomical station at Pentele, under the direction of S. Plakidis, are paid about $30 a month by the Goverment. Explaining how far this goes, Dr. Deming said a luncheon costs more than $1, shirts no less than $8, shoes from $20 to $50, and sugar about $.35 a pound. The government appropriation for instruments, books, periodicals, and other equipment for the entire Department of Astronomy amounts to $350.

Prof. Plakidis, far from having modern equipment, has not even sufficient photographs of modern equipment to demonstrate in his lectures to about 30 students. Suggestions for donations are food and clothing; books and reprints; subscriptions to astronomical and mathematical journals; paper, pencils, pens, even scratch paper; any obsolete adding or computing machine; a slide rule; and the following equipment: a spectrohelioscope (Hale's type), a spectroheliograph, an astrographic refractor (15–20 inch), and a Schmidt camera (36 inch).

Parcels sent by mail are still limited to 11 pounds, and since recipients of parcel post packages of any size in Greece pay a tax of 6,000 drachmas, the equivalent of a day's wages, it is important to send up to the 11-pound limit. Dr. Deming also suggested a group shipment by freight to Prof. Plakidis, who would distribute the materials.

Inquiries and communications about Prof. Plakidis and other scientists in Greece should also be sent to the secretary of the Committee, Grace H. Smith, at the above address.

NRC News

The Division of Engineering and Industrial Research held its annual meeting March 3. Reviews of the major current activities of the Division were presented by the chairmen or the directors of the respective boards and committees.

Frederick M. Feiker, School of Engineering, George Washington University, outlined the proposed plan of organization, objectives, and probable methods of operation of the Building Research Advisory Board, which is being established at the request of the Construction Industry Advisory Council of the U. S. Chamber of Commerce to inventory and correlate technological research on building methods and materials. It is not planned as a board to direct research or to establish or finance research projects.

The work of the Highway Research Board was reviewed by its director, Roy Crum. Now in its 26th year, the Board keeps in close touch with highway research, current and proposed, in every state of the Union. It disseminates highway research information obtained from these surveys by field representatives and other sources in a series of publications entitled "Research Correlation Circulars" and "Highway Research Abstracts." R. L. Morrison, University of Michigan, is chairman of the Board.

The Committee on Quartermaster Problems serves as an advisory group to the Office of the Quartermaster General in the latter's research and development program. Subcommittees have specific responsibilities in the fields of (1) plastics, (2) leather and footwear, (3) textiles, (4) germicides, insecticides, and biologicals, and (5) environmental protection. L. W. Bass, research director, Air Reduction Company, is chairman of this Committee, and W. George Parks is director.

The renewed activity of the Conference on Electrical Insulation was reported by the chairman, Ward F. Davidson, director of research, Consolidated Edison Company. This Conference, established some 20 years ago, held at the Johns Hopkins University last November the best-attended annual meeting in its history. The Conference each year publishes an annual report, including abstracts of papers given at its annual meeting. It also publishes annually a pamphlet now entitled "Digest of Contributions to Insulation Research."

The Committee on Artificial Limbs and the Committee on Sensory Devices are joint committees of the Division of Medical Sciences and the Division of Engineering and Industrial Research of the NRC. Both are advising on research and directing research in their respective fields for the Veterans Administration and the War Department. F. S. Strong, Jr., executive director, Committee on Artificial Limbs, reported for the chairman, Paul Klopsteg, director, Technological Institute, Northwestern University. The CAL program is attempting to develop more useful artificial members for veteran amputees and for the still greater number of civilians. Studies of available artificial limbs have been made, and the Committee participated in a survey of developments in artificial limbs in Great Britain and Germany and other Continental countries. Special attention has been given to control and operation of artificial hands by means of the muscles remaining in the arm stump. Other principal problems have been utilization of a suction socket for attachment of an artificial leg and development of some method of locking an artificial leg to bear weight when in a partially bent position.

The chairman of the Committee on Sensory Devices, George W. Corner, Department of Embryology, Carnegie Institution of Washington, told of studies made by his Committee in attempting to develop compact, hand-held, lightweight guidance devices for the blind. Such devices may be based on reflection of light or of supersonic waves. Attention has also been given to a device intended to read audibly, for the blind. This is actuated by a stylus drawn along the printed line of an ordinary type-wet book page. Magnifying projectors and special reading glasses intended for the aid of partially sighted subjects have also been studied.

The Committee on Ship Construction is advisory to the Bureau of Ships of the Navy Department in a research program on ship hull construction. Through the Bureau of Ships the Committee works very closely with the Ship Structure Committee, joint committee of the Navy, Coast Guard, the Maritime Commission, and American Bureau of Shipping. The problems of this program include testing of large welded and unwelded structures; correlation of such large-scale testing with laboratory tests; metallurgical factors affecting fabricating and service of hull steels; failure of typical ship structures under cyclic loading. The report was presented by Finn Jonassen, research coordinator for the Committee. The chairman is V. H. Schnee, assistant director, Battelle Memorial Institute.

Recent Deaths

Karl G. Berggren, 55, vice-president of Thomas A. Edison, Inc., and manager of the special production department, died in West Orange, New Jersey, February 13. A native of Sweden, he joined the Edison Corporation in 1927.

C. B. Waldron, 81, until recently professor of landscape gardening and forestry, North Dakota Agricultural College, Fargo, died March 6 in Ft. Lauderdale, Florida.

August Frauehan, 45, assistant professor of chemistry, Miami University, Oxford, Ohio, died March 18 after an illness of several months.

Robert Newstead, 87, archeologist and entomologist, died recently at his home in Chester, England. Last year Prof. Newstead had presented his collection of scale insects, including 2,726 microscopic flies and 260 type specimens, to the Natural History Department of the British Museum.

James E. King, 71, emeritus professor of gynecology at the University of Buffalo and a past-president of the International College of Surgeons, died March 9 in Buffalo, New York.

Frederico Nitti, 41, chief of the chemical and bacteriological service of the Pasteur Institute, died March 2 in Rome, Italy.

L. D. Huntoon, 78, former professor of mining and metallurgy at Yale University, died February 23 in Pleasantville, New York.

B. A. Linden, 53, bacteriologist with the Food and Drug Administration since its formation in 1927, died March 9 in Washington, D. C.

Make Plans for—

American Association of Anatomists, annual meeting, April 3–5, Mount Royal Hotel, Montreal, Canada.

American Mosquito Control Association, general meeting, April 5, Hotel Bellevue-Stratford, Philadelphia, Pennsylvania.

The Electrochemical Society, Inc., annual congress, April 9–12, Louisville, Kentucky.

American Chemical Society, spring meeting, April 14–18, Atlantic City, New Jersey.

Institute of Mathematical Statistics, meeting on stochastic processes and noise, April 24–25, New York City.

National Academy of Sciences, annual meeting, April 28–30, Academy Building, Washington, D. C.

American Medical Association, centennial session, June 9–13, Atlantic City, New Jersey.

COMMENTS *by Readers*

The conference of representatives of about a hundred American scientific societies in Washington on February 23 brought about a hopeful renewal of action toward the establishment of a National Science Foundation. However, let no one be deceived into thinking that the goal is actually within reach. The 80th Congress still needs to be convinced of the necessity to the public welfare of a measure which will contribute to its difficulties in making its promised economies and tax relief. It is extremely unlikely that a National Science Foundation Act will be passed by this Congress without very strong pressures from aroused voters "back home."

There is little doubt now that the great majority of American scientists will pull together for the enactment of the best bill that the Inter-Society Committee can get Congressional leaders to accept. There is much doubt that the American public is sufficiently aware of the implications of the problem to be able or willing to exert the necessary influence upon the Congress to get action.

It seems unnecessary to explain further to scientists why a National Science Foundation is needed. The present problem is that of getting the lay public interested, informed, and active. This is an assignment that calls for a quality and quantity of civic responsibility on the part of scientists which they have rarely been willing to assume. Certain small numbers of scientists have always accepted their responsibilities as citizens, especially well informed in certain areas of public importance, but there has been and still is prevalent among scientists a feeling of repugnance against dirtying their hands by exposure to public, and therefore political, problems. The consequence has been that most scientists are silent on public problems, even those directly affecting and affected by science.

American scientists must realize that forces of circumstance beyond their control have thrust them into the maelstrom of modern politics. It is useless to complain that it is unfortunate, because it is a *fait accompli*. Our government, and every other government in proportion to its means, is already pouring hundreds of millions of dollars annually into science laboratories, and has thus already, in plain words, taken them over to a very large degree. The question today is no longer one of whether scientists want government subsidy and control, but simply one of what kind of governmental subsidy and control they will get.

To sit back and be silent while the future of American democratic society is at stake is escapism of a very low order indeed. As a group of citizens, scientists have in general no more rights, privileges, or duties than any other group. But each group in society has its special duty to the Nation as a whole to educate other citizens about those aspects of its own field that concern the general interest. Frequently in American political life we have been treated to the spectacle of special interest groups conniving for their own self-betterment. It would, of course, be a tragedy if American scientists were to follow such a pattern. But the need for a National Science Foundation is not primarily related to the welfare of scientists or even of science. Only a public need can justify the creation of it. Scientists generally agree that an urgent public need exists. As citizens, they have, therefore, a special obligation to educate their nonscientist fellow citizens concerning the basic facts of the problem.

A National Science Foundation serving the interests of the people is unlikely to be set up unless scientists do recognize that fact and begin now in an organized way to inform the American voter. Modern science sets standards of living and wins or loses modern wars, and the advancement and control of it may well be the deciding factor in keeping the peace. Scientists as citizens can, therefore, without much doubt determine the fate of the western democratic world by their action or inaction in the days ahead. (MAURICE B. VISSCHER, *University of Minnesota.*)

Dr. Pilcher's reply (*Science*, February 7, p. 160) to my earlier comment on the establishment of an organized program for cancer research presents a number of admirable arguments for a *coordinated* program on a national scale. I do not believe that my note (*Science*, November 22) contained any matter which was opposed to such an idea. My opposition—and that only on a very mild scale—was to a rigidly *directed* program, rather than to a well-organized one. I believe that the distinction between these approaches is quite clear. Whereas the former is apt to be held down to a certain degree in respect to versatility, the second type of approach is something to be highly desired. Certainly, such a program should be pushed through by all means available.

In the matter of penicillin development, Dr. Pilcher very aptly points out that 11 years were lost between the discovery and the beginning of real work on the problem. I wonder how much of that was due to the fact that even as late as 1929 the real implications of possibilities of scientific research were not at all clear to those who controlled the purse strings? It is unquestionably true that unless the funds are forthcoming, such work is apt to stagnate. The impact of the A-bomb surely served a very loud notice on the world in this respect. (G. M. KOSOLAPOFF, *Monsanto Chemical Company, Dayton, Ohio.*)

Although there are many reasons for attending scientific meetings, the major one for most scientists remains that of hearing original work described in person by those who performed the experiments. In this connection, and in view of my belief that one of the worst aspects of many papers is the use of lantern slides, may I suggest that (a) the only material put on the screen be that which is to be specifically referred to during the talk; (b) long columns of figures, while necessary in a published paper, be omitted from the slides; (c) slides be made with the smallest possible amount of material on each one, so that the observer is conscious of having absorbed their content before the next slide is shown; and (d) a typewritten sheet of paper subsequently photographed to make a slide usually renders the image too small and should be avoided. (G. H. BENHAM, *Illinois Institute of Technology, Chicago.*)

TECHNICAL PAPERS

Control of Cracking of Fruit by Rain

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In submergence trials a very dilute solution of copper sulfate has given full control of cracking of cherries. Preliminary tests indicate that 0.1 per cent anhydrous copper sulfate can be included in the spray or dust for cherry fruit fly control to check cracking after rains. A pretreatment with 0.1 per cent lime hydrate checks cracking but is less effective than copper sulfate. Borax applied as a fertilizer at the rate of 1 pound/tree has reduced the cracking to one-third the amount observed on untreated adjacent areas. Similar beneficial results have been obtained with prunes.

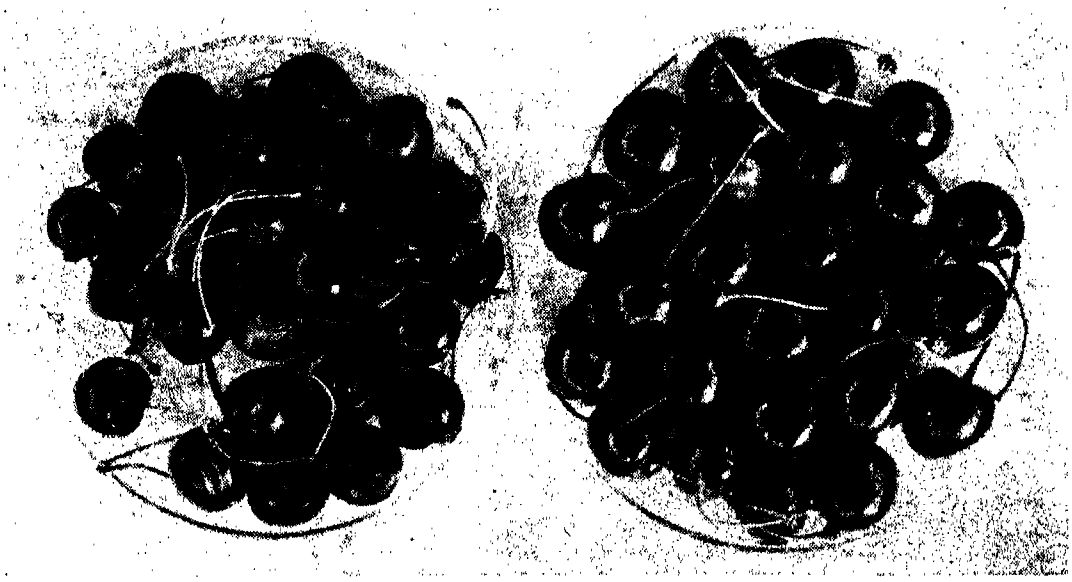

Fig. 1. Left: Bing cherries after 64 hours immersion in distilled water—24 out of 25 cracked. Right: Bing cherries after immersion in .05 per cent copper sulfate—only 1 in 25 cracked.

Borax was freely applied for weed control under a back yard Bing cherry tree early in the spring of 1940, and the subsequent fruit crop was remarkably free from cracks.

Early rains the following September caused over half of the prune crop from trees in fertilizer test plots on Melbourne clay loam to fall to the ground. A count of 200 prunes still on trees of an untreated plot showed 25 per cent to be cracked. Where 30 pounds/acre of borax had been broadcast on the soil of an adjacent area, the cracking was reduced to 9 per cent.

Bing cherries on Amity silty clay loam and Salkum gravelly clay loam showed improved color of foliage and decreased cracking where borax had been applied. Available boron is low in the Salkum soil. These observations led to a study of the value of this and other treatments for reducing cracking of cherries, prunes, carrots, beets, and tomatoes. It was supposed that borax might increase elasticity or toughness of the plant cell wall of fruit skin.

Cherry orchards in eight locations, all on humid soils, were used in cooperative field tests to determine the value of borax for decreasing the splitting of nearly ripe fruits after rains. The trials included several soil types, three varieties of cherries, and different rates and methods of application. Treatments were made early in February of 1942. Counts were usually made of 300 to 2,000 fruits/plot and by two or three persons to determine the percentage of cracked fruit at harvest time. Lack of fruit or damaging rain delayed these trials.

Data for 1942 and 1944 indicated some 25–50 per cent decrease in cracking where borax was applied. Two of the larger orchards with 24–30 trees/plot were re-treated, and observations in 1945 and 1946 showed one-half to one-third as much cracked fruit where borax had been applied. Chemical analyses of soil, leaf, and fruit samples revealed some definite increase in boron content of leaf and slight increase in fruit and available soil boron.

Growers noted improved color of foliage, and one of the cooperators made a commercial application to his whole orchard except for the test rows.

Immersion trials. When a rain of 1.6 inches failed to crack ripe and slightly withered prunes in September 1945, immersion tests were resorted to, using 25 fruits/test. Submergence in water caused all the fruits to crack in 48 hours. A solution containing 0.25 per cent borax delayed and decreased cracking, with the result that some 50 per cent of the fruits were still sound after 48 hours.

Immersion trials were conducted with Bing cherries early in July 1946. In water, 80 per cent cracked in 16 hours and 100 per cent in 64 hours; with stems or only the leaves dipped in water, none cracked. Therefore, water absorption is through the skin. This caused gain in volume and weight. At the red stage of ripening, 100 per cent cracked in 16 hours. When fully ripe, 80 per cent of the nearly black fruits were cracked by immersion for 64 hours.

Solutions of 0.25–0.01 per cent anhydrous copper sulfate completely prevented cracking for four days, while those containing 0.25 per cent fructose, table sugar, sodium chloride, sodium oxalate, zinc sulfate, aerosol, or pretreatment with aerosol or calcium propionate, had little effect.

Pretreatment for 30 minutes with sulfur or calcium hydroxide, followed by immersion in water, decreased cracking somewhat. In two days immersion after the pretreatment with sulfur, 88 per cent were cracked. Pretreatment for 30 minutes with 0.1 per cent calcium hydrate reduced cracking to 16 per cent; that with 0.1 per cent copper sulfate, to 2 per cent. Continuous submergence of ripe Royal Ann cherries in the lime solution resulted in cracking of 16 per cent of the fruit in three days and 24 per cent in four days, while in the same strength of copper sulfate there were no cracked fruits at the end of four days.

Microorganisms in relation to cherry crack. Cracked cherries were removed from the solution after 24 hours; sound fruit and additional cherries developing cracks were withdrawn at 48 hours. Bacteria, yeasts, and molds were determined on 1 per cent dextrose agar. In the case of cracked fruit the cracks and adjacent skin were swabbed with a loop and streaked on poured plates. Sound fruit was rolled directly on the agar surface. In most cases the number of colonies was sufficiently restricted to permit counting, but with the Royal Anns confluent growth in many cases permitted only a rough estimate. Colony characteristics and confirmatory microscopic examination were used to differentiate spore formers (*Bacillus* sp.), micrococci, flavobacteria, and yeast. While the results are not rigidly quantitative, they present an index of the relative abundance of the various groups determined.

Numbers and kinds of microorganisms apparently are not related to cracking; flora of cracked fruit was found to be quantitatively and qualitatively similar to that of the sound cherries.

No molds developed on cracked fruit after removal from the solutions and maintenance at room temperature (25° C.) until shriveled (four or five days); neither was there any macroscopic development of bacteria or yeast.

After three to five days mold and bacterial growth appeared on all solutions except $CuSO_4$ above 0.01 per cent concentration. Bacteria but no molds developed on the 0.01 per cent $CuSO_4$ solution. Sound cherries left in the solutions after 48 hours remained sound at the close of the five-day observation period.

Trials with protective sprays. Pretreatment of very ripe Royal Ann cherries with 0.1 per cent copper sulfate spray and then repeated spraying caused only 1 per cent cracking in fruit; the water spray without pretreatment caused 6 per cent. Further copper tests with prunes and related pressure tests indicate bearing strength increased. It appears probable that 0.1 or 0.05 per cent anhydrous copper sulfate can be included in the cherry fruit fly spray or 3 per cent with the sulfur-containing dust for prunes and applied early in the morning.

Microscopic examination. Examination of skins of fruits after 48 hours submergence indicates that water increased turgidity of cells compared to that from lime, while plasmolysis was more in evidence after the copper treatment. In all cases there was a gain in weight during immersion.

Discussion and conclusion. Copper sulfate has given control of cracking of fruit in immersion tests, and preliminary spraying tests indicate that its use as a spray or dust will check cracking of fruit due to rains. The benefit reported from use of Bordeau spray (*3*) appears to be due more to the copper than the calcium contained. Bordeau reportedly increases transpiration (*1*) and may decrease fruit size.

How copper sulfate solution functions to prevent cracking of fruit is not fully determined. Cracking after rain has been related to osmotic concentration of the fruit juice, turgor of fruit, temperature, and skin permeability (*4*). Possibly the fruit cells are affected so less water is absorbed or held. The copper sulfate is effective at too low a concentration to have any appreciable osmotic effect. No specific fungi or other causative organism was found. It now appears more probable that the copper sulfate has a toughening effect (*2*) on the fruit skin comparable to that of tannin on leather.

It appears that the solution or spray, to be effective and noninjurious, should have a concentration of 0.1 to .01 per cent. Perhaps this material can be included in the cherry fruit fly spray or early morning dusting trials. Dilution of anhydrous copper sulfate with diatomite or other fine inert powder is suggested.

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Methionine Metabolism and A-Aminobutyric Acid

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A-amino-n-butyric acid has been identified by paper chromatography in the urine of a case of Fanconi syndrome (*1*).

It also occurs in appreciable amounts in normal blood and urine and has been found in a dilute acetic acid extract of yeast. It would appear to be very generally distributed in tissue nonprotein nitrogen.

On giving methionine (10 grams) by mouth, an increased output of α-aminobutyric acid and of methionine sulfoxide, as well as of methionine, can be detected in the urine, the overflow of all three following a similar course. This has been seen in a normal subject but was much more obvious in a case of Fanconi syndrome, in which "renal" aminoaciduria occurs.

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The conclusion is drawn that the methionine can be metabolized to α-aminobutyric acid and that it is probably the main source of the latter, since it does not, of course, occur in the protein of the diet. The fate of the carbon chain of the former now seems clear. A reinvestigation of the possible role of α-aminobutyric acid in the body is indicated. If its presence is essential, methionine may have to be wasted in order to produce it, and, in that case, giving it to animals on a low methionine diet may exert a methionine-sparing action.

Methionine sulfoxide may be of significance in oxidation-reduction potential. It can oxidize cysteine to cystine *in vitro* (*2*). Methionine, on standing under various conditions, readily changes largely into the sulfoxide and may therefore act as an oxygen carrier. In view of this easy oxidizability, however, its presence in the urine after methionine feeding needs more careful checking. It may have been formed by aerial oxidation. The validity of procedures for the determination of methionine in urine by oxidation reactions (H_2O_2, etc.) also arises.

Further details of these findings, which arose out of an investigation into the aminoaciduria in Fanconi syndrome, have been submitted to the *Biochemical Journal*.

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Failure to Produce Neoplasms in Rats by Feeding Heated Wheat-Germ Oil

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The announcement by Rowntree (*2*) in 1937 of the occurrence of neoplasms in Wistar rats following the ingestion of crude wheat-germ oil created considerable interest. The suggested relationship to diet as well as the production in experimental animals of malignant lesions of the gastrointestinal tract were factors of scientific importance. Attempts to duplicate these results were made in many laboratories, unfortunately without success (*1*). Since one of us (G. D.) had prepared some of the original wheat-germ oil used by Rowntree in his successful experiments, an attempt was made to duplicate his work, using oil prepared by the same operator and under the same laboratory conditions. Rowntree's diet was followed in detail, and Wistar rats were fed for almost a year. No neoplasms were produced (unreported work).

Some recent evidence has suggested that heated fats may contain carcinogenic factors possibly due to the conversion of sterols to carcinogens by heat (*3*). Wheat-germ oil is rich in sterols, and Rowntree, in the preparation of his diet, actually might have changed some of the sterols in the wheat-germ oil to carcinogens, since the oil was usually heated again before use to insure that no trace of ether smell remained.

In order to test this possibility, crude wheat-germ oil was prepared exactly as it had been previously. It was then heated at 275° C. for two hours. Three liters of heated oil were mixed with 10 kg. of basic diet in accordance with Rowntree's directions. Thirteen female Wistar rats with an average weight of 64 grams and 14 male Wistar rats with an average weight of 65.5 grams were started on the diet in November 1945. The animals grew somewhat slowly, compared to colony rats, but the growth rate was steady and the animals appeared healthy. There were a number of deaths due to colds and pneumonia. The surviving animals were killed and autopsied in July 1946. Seven males averaging 253 grams and 5 females averaging 213 grams survived. The condition of all animals was excellent, with no suggestion of any malignant lesions.

This evidence would seem to indicate that the sterols in wheat-germ oil are not converted to carcinogens by heat. The heat conversion of sterols to carcinogens was apparently not a factor in Rowntree's production of gastrointestinal lesions in the rat.

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The Occurrence of Two Fertile Florets in the Spikelets of *Chloris*

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During the writer's experience in seed analysis Rhodes grass (*Chloris Gayana* Kunth) was frequently received for purity analysis and for germination test. Early examination of spikelets of this species disclosed that many contained a fertile pedicellate floret in addition to the fertile basal and sessile floret. The presence of caryopses was the criterion employed.

Thus far no confirmation of this observation has been found in the available grass and general floras examined. The seed analyst is perhaps the person best situated to make such an observation, since each of his many routine analyses requires the examination of thousands of individual seeds or seed units, but his usually elementary knowledge of taxonomy might lead him to overlook the significance of such a fact.

Descriptions of the genus *Chloris*, as far as the writer has been able to determine, appear to be unanimously in agreement on the occurrence of one fertile floret in the spikelet, and this the basal, sessile floret. For example, Hitchcock (*1*) states: "Spikelets with 1 perfect floret, sessile, . . . the rachilla disarticulating above the glumes, produced beyond the perfect floret and bearing 1 to several reduced florets consisting of empty lemmas. . . ." In no instance was there more than one floret in the spikelet described as fertile in the literature available. Silveus' description (*3*) is worded identically, and those in other floras are either essentially similar or identical.

As the average purity, or seed set of *C. Gayana* by weight, was found to be approximately 25 per cent (37 lots) (*2*), it may be assumed that the number of pedicellate florets maturing caryopses would likewise be a fraction of the total number of perfect pedicellate florets. One count showed that one-third of the florets of spikelets containing caryopses were pedicellate. Another count yielded 25.2 per cent pedicellate florets with caryopses and represented a lot of more than 1,000 pounds of commercial seed. Detailed examinations are being continued.

Other species of the genus containing such florets are the native *C. latisquamea* Nash and *C. verticillata* Nutt., of the subgenus *Euchloris*. While no indication of perfect pedicellate florets has been found to date in *C. cucullata* Bisch., *C. ciliata* Swartz, *C. canterai* Arech., *C. divaricata* R. Br., and *C. virgata* Swartz, all indigenous to or naturalized in Texas, it is probable that insufficient material was examined. *C. verticillata*, a prolific seeder and a very common species, contained 6 per cent of spikelets with mature or maturing caryopses in the pedicellate spikelets, all of which also contained caryopses in the basal florets.

In view of the above findings, it is proposed that the generic description of *Chloris* should include wording somewhat as follows: "Spikelets 3- to 4-flowered, the florets reduced progressively upward; perfect florets, 1 to 2; the first, basal and sessile; the second, pedicellate on the prolonged rachilla and perfect staminate, or neuter; the third staminate, or reduced to lemma and palea or only the lemma; and the fourth, when present, reduced to an empty lemma, or represented only by the rachilla apex, the two uppermost florets forming a club-shaped rudiment."

Specimens of the three species found to have perfect pedicellate florets have been submitted to Agnes Chase, agrostologist of the Smithsonian Institution. The writer would appreciate further confirmation of the facts presented and will be glad to examine other species of *Chloris* for additional information.

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Translocation of a Radioactive Plant-Growth Regulator in Bean and Barley Plants

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Previous experiments have shown that the application of a nonradioactive growth regulator (2,4-D) to a leaf or the roots of a young bean plant causes a stimulus to be translocated to the stem, where it brings about an easily detected growth response (curvature). A study of this type of response has revealed that the translocation of such a growth-regulating stimulus from a leaf to the stem is associated with the translocation of sugars along the same course and that it moves mainly in living cells (phloem); but when the stimulus is translocated from the roots, it can apparently move within the stem in nonliving cells (xylem) (*3*). However, neither the amount of stimulus translocated and its entire course of movement throughout a plant nor the absorption and translocation of such a stimulus in grasses can be detected readily on the basis of curvature measurements.

The present investigation, in which a radioactive growth-regulating substance was used, was undertaken (a) to determine whether or not the radioactive component was absorbed and translocated by representative dicotyledonous and monocotyledonous plants, and (b) to measure the amount of the radioactive component translocated and accumulated in various parts of the treated plant.

EXPERIMENTAL METHOD

The compound, 2-iodo-3-nitrobenzoic acid (INBA), used in this study causes form changes in leaves of bean seedlings when a few micrograms are applied to one primary leaf of each seedling. The response to INBA was found to be similar in character to that elicited by 2,3,5-triiodobenzoic acid (*4*). Radioactive iodine^{131} was used as the tracer atom because of the relatively high energy of its beta radiation (0.67 Mev), its availability in experimental quantities,[1] its convenient half-life (8.0 days), and the ease with which it could be incorporated into INBA. Synthesis was accomplished by replacing the mercury by iodine in anhydro-2-hydroxymercuri-3-nitrobenzoic acid (*1*). With this method the synthesis can be completed in less than three hours, and no isomers or troublesome by-products are formed. The method has the disadvantage, however, that mercuric iodide, a by-product of the reaction, contains an appreciable fraction of the radioactive iodine used in the synthesis. This disadvantage can be minimized by employing an iodine solution of high specific activity or might be circumvented by using a synthesis involving the diazotization of 3-nitroanthranilic acid (*2*).

Radioactive INBA was synthesized on a submacroscale as follows: The reaction was conducted in a round-bottomed pyrex vessel of 15-ml. capacity having two necks fashioned from interchangeable ground-glass joints. A pyrex Liebig condenser was inserted in one outlet and a ground-glass stopper in the other. Stirring of the reaction mixture was accomplished by means of a small, hollow, sealed, glass capsule containing several lengths of soft iron wire, which was externally rotated by means of a motor-driven permanent magnet. An iodine solution was prepared by dissolving 200 mg. of potassium iodide in 7.5 ml. of radioactive iodine solution[2] and adding a solution of 230 mg. (1.39 mM) of potassium iodide and 360 mg. (1.42 mM) of stable iodine in 0.35 ml. of water. To a boiling solution of alkali (70 mg. of NaOH in 2.1 ml. of water) in the reaction flask was added portionwise, with stirring, 460 mg. (1.26 mM) of anhydro-2-hydroxymercuri-3-nitrobenzoic acid. Boiling and stirring were continued during the dropwise addition of 0.12 ml. of concentrated HCl. Heating was stopped and 0.04 ml. of glacial acetic acid was added. To this rapidly stirred mixture the iodine solution was added rapidly from a glass, 10-ml. hypodermic syringe equipped with a capillary delivery tube attached to the barrel. The reaction mixture was stirred and refluxed for 5 minutes and was then made alkaline (30 mg. NaOH), centrifuged, and the supernatant solution acidified to Congo red (ca. pH 4) by adding concentrated HCl. The precipitated INBA was collected by centrifugation and washed successively with a small volume of water and a solution of 0.1 gram potassium iodide in 2 ml. of water. After centrifuging, the acid was dissolved in 2 ml. of hot 50 per cent ethanol centrifuged hot and cooled to crystallize. The acid was recrystallized, using the same procedure, to yield 206 mg. of product (49 per cent of theory based on the 3-nitrophthalic acid used in preparing the anhydro-2-hydroxymercuri-3-nitrobenzoic acid) melting at 204.5–207.5° C. (cor.)—reported melting point (*1*), 204–205.5° C. Analysis calculated for $C_7H_4INO_4$: C, 28.69; H, 1.37; I, 43.31; N, 4.78; neutral equivalent, 293. Found: C, 28.83, 28.69; H, 1.84; 1.75; I, 44.13, 43.99; N, 4.27, 4.28; neutral equivalent, 295.5, 297.1.

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[1] Obtained through the Isotopes Branch, Manhattan District, Oak Ridge, Tennessee (*5*).

[2] Radioactive iodine was received on August 26, 1946, in the form of a N/10 sulfuric acid solution having a specific activity of 1 mc./ml.

Two series of reference standards for the radioactivity measurements, one of bean leaf tissue and one of bean petiole tissue, were prepared by adding known amounts of radioactive INBA to known amounts of the dried, ground (20 mesh) plant material. The acid was in the form of a dilute aqueous solution prepared by dilution of an alcoholic solution of the acid. At least 10 ml. of the aqueous solution was added for each gram of dried plant material to insure adequate distribution of the acid. The watery suspension of plant material which resulted was thoroughly mixed in a ball mill, dried (80° C.), and reground to 20 mesh in a Wiley mill. Standards of both leaf and petiole tissue were prepared to contain 1 part of the radioactive acid in 5000, 1 in 10,000, 1 in 100,000, and 1 in 1,000,000 parts of tissue.

For tracing the movement of radioactivity through bean (*Phaseolus vulgaris*) and barley (*Hordeum vulgare*) seedlings, the radioactive INBA was applied to a leaf of these plants as a paste made by first dissolving 25 mg. of the acid in 1 gram of melted polyethylene glycol (Carbowax 1500), followed by thorough mixing with 4 grams of melted lanolin. In treating leaves, 5-mg. aliquots of the paste (25 µg. of INBA) were applied to the upper surface and along the midrib of one primary leaf of each bean plant and as a band about 0.5 cm. wide across the upper surface and near the tip of the first true leaves of barley seedlings (Fig. 1). The bean plants used had well-developed primary leaves, but the trifoliate leaves were still folded tightly in the terminal buds at the time the plants were treated. The barley seedlings had one well-developed true leaf and a second leaf rapidly expanding at the time the plants were treated.

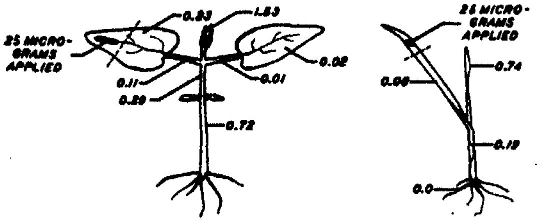

FIG. 1. Diagram showing distribution of radioactive INBA (µg.) in various parts of bean (left) and barley plants 3 days after treatment. Distal ends of treated leaves were severed as indicated by broken line and discarded prior to sectioning of plants.

Three days after treatment the plants were carefully divided into parts, and the corresponding parts were combined, dried (forced draft oven at 80° C.), and ground (20 mesh) in a Wiley mill. One hundred mg. of each sample was spread uniformly over the surface of a shallow plastic cup, 3.5 cm. in diameter, and the radioactivity of each was measured by means of an Edelmann electrometer-ionization chamber.[3] Measurements of the radioactivity of the tissue standards and unknown samples were made in the same manner on the same day. Background measurements (natural radioactivity) were made at intervals during each series of measurements.

RESULTS AND CONCLUSIONS

The marked inhibitory action of INBA on the growth of the dicotyledonous bean plant and its slight action on the monocotyledonous barley plant are illustrated in Table 1.

TABLE 1

EFFECT OF RADIOACTIVE INBA ON GROWTH OF PARTS OF BEAN AND BARLEY PLANTS

Part	Untreated* control (mg./plant)	Treated* (mg./plant)	Wt. reduction (%)
Bean			
Primary leaf	218	193	11.5
Bud	15	9†	40.0
First internode	33	28‡	15.2
Hypocotyl	94	78†	17.0
Total above-ground portion	360	308‡	14.4
Barley			
First leaf	130	116	10.8
Second leaf	120	112	6.7
Stem§	122	110	9.8
Total plant	372	338	9.1

* Figures represent average fresh weight per plant 3 days after treatment, based on pooled samples of corresponding parts of 15 bean and 12 barley plants.

† Difference between corresponding parts from treated and untreated plants highly significant.

‡ Difference between corresponding parts from treated and untreated plants significant

§ Includes the stem and the section of leaves that sheathes the growing point.

In the bean plant the compound is most effective in inhibiting development of the bud. It should be pointed out that there is no apparent difference in the growth responses resulting from application of stable INBA and of radioactive INBA when equal amounts of the two compounds are applied separately to the leaves of bean seedlings.

The measurements given in Table 2 indicate that the compound was apparently absorbed by the leaves of bean seedlings and that it was translocated from treated leaves to the stems of the plants, where it accumulated mainly in the terminal buds and in the hypocotyls (Fig. 1). Greatest reduction in growth was observed in those parts of bean plants which became most highly radioactive as a result of the treatment.

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[3] The authors wish to express their appreciation to Dean Cowie, P. H. Abelson, and Charles Ksanda, Department of Terrestrial Magnetism, Carnegie Institution, for permitting them to use an electrometer and for guidance and assistance during these investigations.

Radioactive INBA was also apparently absorbed by the leaves of barley plants and accumulated mainly in the second leaf, which developed rapidly during the period of treatment (Table 3, Fig. 1).[4] In contrast to the results obtained with the bean plants, the presence of radioactive INBA in barley plants was not associated with a statistically significant decrease in their rate of growth. Since INBA appears to be absorbed by both bean and barley plants in these experiments, it must be inferred that the growth-inhibiting effects of INBA in the bean plant and its failure to produce significant inhibition in the barley plant must be due to differences either in INBA concentrations in the two plant types or in the manner in which INBA reacts with the plant constituents in each case.

TABLE 2

RESULTS OF RADIOACTIVITY MEASUREMENTS ON PARTS OF BEAN PLANTS AFTER TREATMENT WITH RADIOACTIVE INBA

Plant part	Fresh wt. 46 plant parts (mg.)	Dry wt. 46 plant parts (mg.)	Net activity*	INBA/100 mg. dry plant part (γ)	INBA/single plant part† (γ)	INBA/unit net activity (γ)
Terminal bud	4,610	544	2.23	12.9	1.53	
Treated leaf section	34,700	3,820	0.048	0.277	0.230	
" petiole	7,940	526	0.162	0.935	0.107	
Untreated leaf	46,200	5,080	0.003	0.017	0.019	
" petiole	8,180	554	0.018	0.014	0.001	
First internode	17,400	1,274	0.184	1.06	0.294	
Hypocotyl	32,400	2,876	0.200	1.15	0.719	
Leaf standard: 1/10,000			1.59	10.0		6.29
Petiole standard: 1/10,000			1.82	10.0		5.49
			1.67	10.0		5.99
Leaf standard: 1/100,000			0.114	1.00		8.77‡
Petiole standard: 1/100,000			0.188	1.00		5.32
Leaf standard: 1/1,000,000§						
Petiole standard: 1/1,000,000§						
Average						5.77

* Corrected for background.

† Calculated from the relationship, $\frac{a \times b/100}{46}$, where a = dry weight (mg.) of 46 plant parts and b = INBA (γ)/100 mg. of plant part.

‡ Not included in average.

§ Radioactivity too weak to detect.

TABLE 3

RESULTS OF RADIOACTIVITY MEASUREMENTS ON PARTS OF BARLEY PLANTS AFTER TREATMENT WITH RADIOACTIVE INBA

Plant part	Fresh wt. 37 plant parts (mg.)	Dry wt. 37 plant parts (mg.)	Net activity*	INBA/100 mg. dry plant part (γ)	INBA/single plant part† (γ)	INBA/unit net activity (γ)
Treated first leaf	3,600	275	0.139	1.08	0.080	
Second leaf	3,440	384	0.919	7.16	0.743	
Stem and sheath	3,290	220	0.419	3.26	0.194	
Root	8,800	750	Nil			
Untreated whole barley			Nil			
Leaf standard: 1/5,000‡			2.42	20.0		8.26
Petiole standard: 1/5,000‡			2.76	20.0		7.25
Leaf standard: 1/5,000‡			2.38	20.0		8.40
Petiole standard: 1/5,000‡			2.63	20.0		7.60
Leaf standard: 1/10,000‡			1.04	10.0		9.62§
Petiole standard: 1/10,000‡			1.34	10.0		7.46
Average						7.79

* Corrected for background.

† Calculated from the relationship, $\frac{a \times b/100}{37}$, where a = dry weight (mg.) of 37 plant parts and b = INBA (γ)/100 mg. of plant part.

‡ These standards were prepared from parts of the bean plants and are the same ones reported in Table 2. A comparative analysis made at a later date between unit net activities of the bean plant standards and whole barley plant standards of the same concentration failed to show a difference greater than the 10–15 per cent which exists between duplicate analyses.

§ Not included in average.

The appearance of radioactivity in the plants following treatment with radioactive INBA does not prove, of course, that the intact INBA molecule actually entered the plant and was translocated as such. In subsequent experiments it has been shown, however, that the application of elemental iodine, 3-nitrobenzoic acid, or 3-nitrosalicylic acid fails to bring about responses in the bean plant similar to those resulting from application of INBA. Although these data do not constitute conclusive proof, it appears, in the case of the bean plants at least, that INBA enters the plants in molecular form and is translocated as such.

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[4] The fact that no radioactivity could be detected in the large, composite barley root sample means only that an insignificant portion of the applied INBA is present in the roots three days after application. This does not preclude the possibility, however, that a relatively high concentration of INBA might have been found in the actively growing root tips if it had been feasible to sample and measure the radioactivity of this extremely small fraction of the plant. No measurements were made on the roots of treated bean plants.

IN THE LABORATORY

Inactivation of 2,4-D by Adsorption on Charcoal[1]

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A method has been found which will inactivate some preparations of 2,4-D by adsorption on activated charcoal. This method is important because of its simplicity and its thoroughness of action. Substances and equipment which have been in contact with 2,4-D frequently carry small residues which are injurious to plants. Inhibition and injury of succulent plant tissues such as bean and tomato have been observed to be caused by dilutions as low as ½ ppm, and hence it has been almost impossible to clean adequately equipment which has been used to hold herbicidal preparations. Also, instances may occur where the separation of 2,4-D from other materials is desired.

Experiments have shown that a solution of the water-soluble powder (sodium salt of 2,4-D, as prepared by the Dow Chemical Company) containing 1,000 ppm of the active principle can be safely sprayed on all but very young bean plants after being mixed and shaken with 1 per cent activated charcoal (Norit A). Bean plants sprayed with this material shortly after emergence indicate by a very slight nastic response that the adsorption on the carbon is not complete. However, the amount of active substance not adsorbed is so small that it can be disregarded for all practical purposes. The addition of a larger percentage of charcoal results in complete inactivation.

TABLE 1

QUANTITATIVE ADSORPTION OF 2,4-D ON NORIT A AS ESTIMATED BY RESPONSE OF 10-DAY-OLD BEAN PLANTS

Concentration of 2,4-D (ppm)	Norit A in suspension (%)	Effect of application by	
		Drop method	Spraying
1,000	1	0	0
5,000	3	0	++
5,000	5	0	+
10,000	5	0	++
10,000	10	0	+

0 = no visible effect; + = very slight effect; ++ = slight effect.

A hand sprayer which had been used to apply 2,4-D solution at the excessive concentration of 10,000 ppm was freed from injurious traces by rinsing with a 1 per cent Norit A suspension for 2 minutes. Young bean plants were uninjured by applications of inert solutions made with this same hand sprayer immediately after rinsing as described.

Tests carried out to determine the degree of inactivation have given positive results, as shown in Table 1. These were made by the drop method developed by Mitchell and Hamner (*2*) as well as by spraying entire plants.

It should be emphasized that the carbon treatment inactivated the water-soluble powder. Tests indicate that certain oil preparations, though somewhat affected, are inactivated much less readily. Further tests are being conducted to establish the behavior of other types and grades of carbon preparations.

It appears that the findings here reported may offer an explanation for variable results with soil treatments of 2,4-D (*1*). It had been found that weed seeds were not as readily destroyed in certain muck soils as in sandy soils. Perhaps some muck soils adsorb 2,4-D in the same manner as does charcoal.

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[1] Journal Article No. 859 (n.s.) from the Michigan Agricultural Experiment Station.

Pilometric Measurements and the Rheological Properties of Hair

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In man, various clinical conditions involving the loss of hair are known. Successful therapy, both locally or systemically, to counteract the loss of hair must be based on controlled experimentation. This calls for a clinical test which permits careful measurement of the firmness with which a single hair is attached to the skin and the determination of certain rheological properties (*5*) of the hair, such as its yield value, elasticity, and tensile strength.

An instrument was devised for a study of the effect of a systemic treatment on the firmness of attachment of hair to the scalp in certain clinical conditions.[1] Since then, a second instrument with significant improvements, termed "pilometer," was developed in collaboration with the Friend Laboratories, New York City.

The first device was of simple construction and consisted of a small clamp, a hook, and a ball-bearing pulley fastened to a vertical stand. The clamp was designed to hold the hair and was fastened to a silk cord which went over the pulley. A light-weight tube (Lusteroid) of 100-cc. capacity was hung on the hook attached to the other end of the cord. Clamp, cord, and tube had a total weight of 8 grams. The tube served as a container for weights in grams or water.

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[1] The author wishes to thank Dr. Frank Co Tui, of New York University, for suggesting the problem of devising such an instrument.

The improved device (Fig. 1) is based on the same principle but has a balance in place of the tube. It is also equipped to permit the measurement of the elasticity of a hair and the degree of deformity on stretching.

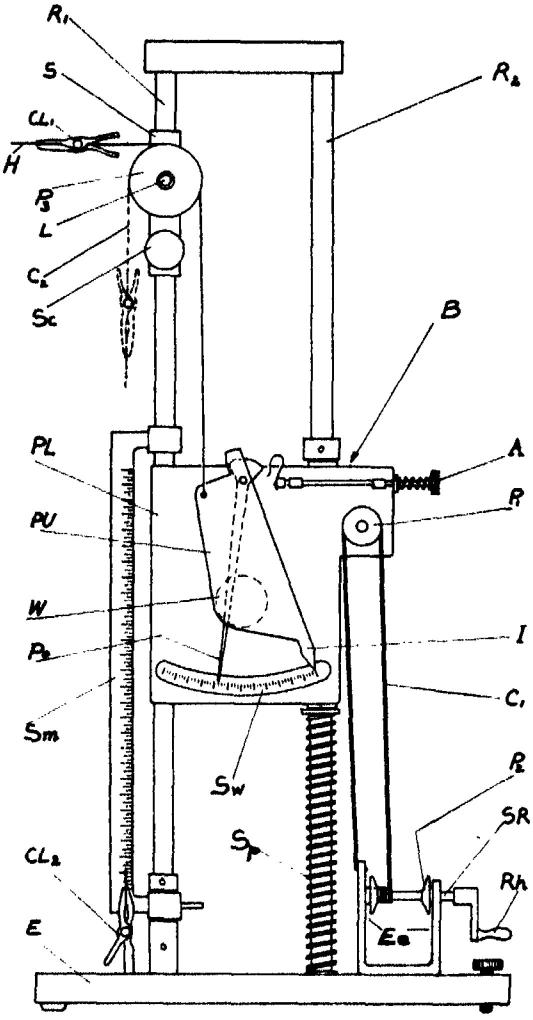

FIG. 1. Pilometer.

The balance, B, moves on two parallel, vertical rods, R_1, R_2, mounted on a base, E. A spring, Sp, to control the movement of the balance, is placed on rod R_2 between the base and the balance. The balance consists of the pendulum, PU, swinging on a plate, PL. The pendulum carries any given weight, at W, and has a projection which serves as the indicator, I. Two pulleys, P_1, P_2, are provided to lower the balance, one being fastened to the balance, and the other to an elevation, Ee, on the base. One end of a cord, C_1, is attached on the elevation, passes up and over pulley P_1, and returns to pulley P_2, which rotates on its axis, a small rod, SR. A third pulley, P_3, on ball bearings, L, is vertically movable on rod R_1 by means of slide S, which can be affixed by a head screw, Sc, to any desired height. The balance, B, is pulled slowly downward without vibrations by means of the rotating handle, Rh. One end of another cord, C_2, is attached to the pendulum of the balance and the other end to the clamp, CL_1, which holds the hair, H, while attached to the skin or after its detachment.

For measurements of properties of an isolated strand of hair, clamp CL_1 serves to hold one end, and clamp CL_2, at the base of the instrument, the other. A vertical scale, Sm, is used to measure the length of the strand of hair.

The instrument is operated as follows: A strand of hair still attached to the skin is clamped in CL_1, and the rotating handle is turned slowly until the hair becomes detached. The stress applied to the hair increases while the indicator moves along the scale, Sw, simultaneously with a pointer, Po, which is mounted behind the indicator and which remains at the maximum position after the hair becomes detached. Thereupon the indicator returns to zero. By pushing a button, A, the pointer can be brought back to zero.

The detached end of the hair is now put into clamp CL_2, and the rotating handle is again operated, but now for the purpose of measuring elasticity, yield value, and tensile strength.

For obtaining comparative values, hair was selected from an area located on the midline between the vertex and the linea nuchae. In a group of 42 healthy, white, male and female adults, the firmness of attachment ranged between 22 and 60 grams, averaging 34 grams; the tensile strength, between 65 and 120 grams, averaging 95 grams. Of interest are the findings in a small group of 4 male adult Chinese, the firmness of attachment being 64–88 grams, and the tensile strength 141–165 grams. These values definitely exceeded those obtained in the group of Whites. The individuals of the Chinese group may be exceptional, but the values obtained indicate the possibility of racial differences. The tensile strength measurements of Leftwich (*4*) were made with a comparatively crude method and gave an average of 7 ounces, or more than 200 grams. His subjects were presumably Whites.

It must be realized that the values should be amplified by a much larger number of observations in different male and female, racial and age groups on healthy subjects and on hair from various parts of the scalp as well as other regions of the body. In our experiments the tensile strength was measured immediately after the hair was pulled. Such tests should be made on several samples from the same area. It would also seem necessary to know how the hair has been treated prior to the tests. We found wide variations in comparing values obtained from different parts of the scalp or the body of the same individual.

The attachment of the hair to the skin may be supposed to be the firmness with which the cuticle of the hair is attached to the cuticle of the internal root sheath. Lower values of firmness of attachment or of "cuticle firmness" which occasionally are obtained upon several pullings may be due to progressive separation of the cuticles when the single hair is about to fall out. It is not yet known what brings about this process and what makes for firmness of hair attachment.

The pilometer permits clinical studies. Such investigations should be amplified and correlated with the analysis of X-ray diffraction patterns. Such patterns have been investigated recently by Astbury and his associates (*2*, *3*). Their studies of the elastic properties and molecular structure of unstretched and stretched hair resulted in a number of practical implications. Astbury (*1*) observed that if a hair is considerably stretched and steamed for several hours while stretched, the external scale sheath of the hair often breaks up into loose, short, cylindrical sections. He points out that certain procedures to secure "permanent waves" are "inseparable from irreversible changes in the keratin molecule, changes that must be described, however reluctantly, as damage." We obtained from different subjects values of tensile strength which, in some cases, did not differ appreciably after several times of stretching, while in others the tensile strength decreased markedly.

Pilometric measurements may prove to be useful in testing both local and systemic treatments of any given substance in experimental subjects. The pilometer promises to be a tool by which the experimental biologist and dermatologist may test certain locally or systemically applied treatments for hair in health and disease.

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A New Method for the Direct Recording of Prolonged Time-dependent Processes[1]

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Loop and cathode-ray oscillographs at the present time have superseded all other methods of recording processes with temporal variations, although for some purposes they have certain deficiencies.

In medicine, for instance, it is regarded as a disadvantage that the process of photographic developing intervenes between recording and evaluation. Also, the standard recording scale requires excessive quantities of paper and film if a long record is to be made without changing the cassette. Thus, not only are there development difficulties, but analysis of the process as a whole is difficult. For these reasons some primitive, direct methods of recording (e.g. the soot kymograph) are still in use, although they do not meet present requirements as far as their frequency characteristics are concerned.

Medical research requires an efficient method of direct and continuous recording. A method of this type would serve essentially to correlate the experimental phenomena with the recording, to control the experiment according to the changes in the oscillogram, or to enable observation of certain functions (e.g. electrocardiogram) during an operation. It would also be useful for teaching and demonstration in schools. In many cases the greatest advantages of the loop and cathode-ray oscillographs, their frequency characteristics, are not exploited. In medicine, for example, while frequencies below 200–300 cycles often are recorded with the cathode-ray oscillograph, it is possible to develop devices for direct recording. It is of no importance that the recordings are not as large as usual. If the thickness of the record curves is sufficiently small compared with the maximum amplitude, the recording may easily be magnified suitably by projection on a screen. Moreover, a small recording has the advantage that a substantially longer period of registration is placed on the same amount of material. Generally speaking, this is the only method possible for making actual continuous study.

Such a method[2] has been developed on an electromechanical basis and is described below.

The cutting of a phonograph record may serve as an example in which maximum amplitudes of 0.08 are recorded. The resonant frequency of the phonograph recording system is about 5,000 cycles. Since an upper cutoff frequency of 500 cycles is sufficient for the present problem, the maximum amplitude required may be brought to the necessary magnitude by a small elastic force coupled to a lever transmission. For an electromagnetic recording system with a frequency range up to 500 cycles and an electrical input of 3 watts, this amplitude is 0.5 mm. (length of stroke, 1 mm.).

Such a magnitude may be seen directly, as may be, therefore, the total recording. On the other hand, for accurate evaluation of individual parts of the recording, they may be magnified optically to a maximum of 4–10 cm. by ordinary means and with normal space requirements. With suitable optics a much larger magnification is possible and may be used for lecturing and similar purposes.

The oscillographic method developed on this basis works as follows (Fig. 1):

The processes to be recorded (electrocardiogram, cerebral potential variations, blood pressure, etc.) are converted into electric quantities and conducted to an amplifier; this operates the recorder (S) which carries a stylus to cut the lacquer coat of the glass disc (G). While the disc is rotating, the recorder is moved radially by foot gears (V); thus, as on phonograph records, the groove forms a spiral. An illuminating device (B, below disc), placed close to the stylus, is coupled to and moves with the recorder. The optical system (A, above disc) magnifies the process recorded by means of an angular mirror (W) and projects it onto a screen (P). At a moderate disc velocity (about 20–30 cm./second on the screen for electrocardiograms) it is easy to observe the process while it is being re-

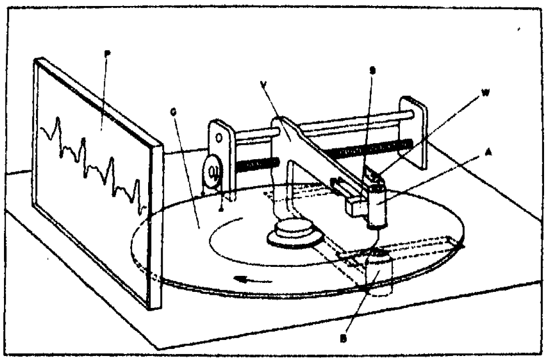

Fig. 1. Schematic representation of the recording method.

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[1] Technical Report No. 11 of the AAF Aero Medical Center, Helmholtz Institute, Branch Nussdorf/Inn, Germany, March 23, 1946.

[2] The measurements were carried out by A. Habermann.

corded and to reproject it later for exact evaluation or for copying.

The "pitch" of a spiral record whose maximum amplitude is 0.5 mm. is about 2 mm. If 5 cm. of a 30-cm. disc is used, there is an available recording length of 19 m. Compared with the usual electrocardiogram, the maximum amplitude of which is about 4 cm., this corresponds to 760 m. of film. An electrocardiogram may therefore be recorded continuously for 100 minutes without changing the disc.

When the angular velocity is kept constant, the spiral recording has the disadvantage that the time scale is different at different radial distances from the center of the disc. This can be compensated by a special timing device. Or, since the speed of rotation is low (0.25/minute for the electrocardiogram), a drive which will maintain a constant linear velocity just at the recorder can be designed relatively easily.

Fig. 2 shows a laboratory model of the apparatus. If required the zero line may be recorded at the same time by the addition of a stationary stylus, or another process may be recorded simultaneously by a second recorder. The device is superior to photographic methods because the thickness of the lines is constant, whatever the recording velocity.

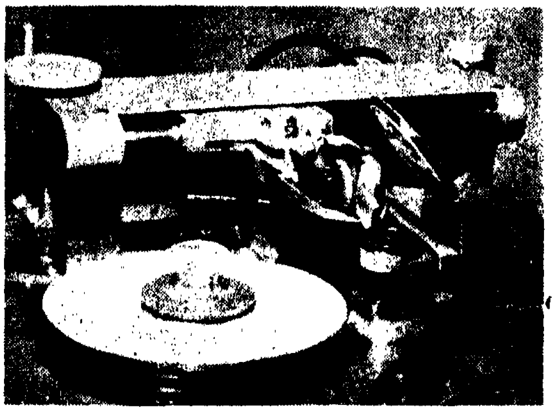
FIG. 2. Laboratory model of the recording device.

An electromagnetic phonograph system was first used as the recorder. It was adapted to the present purpose because of the experience gained while designing it. The stylus amplitude required was determined by varying the armature's elastic control force and by lever transmission. Optimal conditions (*i.e.* amplitude as great as possible at linear amplitude characteristics and the armature's resonant frequency as high as possible) are ensured by adapting the geometric shape of the vibrating system correctly to the magnetic forces available. By utilizing the magnetizing curve up to saturation (Saettigung), these were increased to the limit attainable. The recorder is arranged in such a way in relation to the disc that the armature's axis of rotation is not parallel to the disc's face (as in cutting phonograph records) but perpendicular to it. This is necessitated by the fact that the stylus' point describes a flat arc and otherwise would move off the glass surface.

The recorder is operated with constant current in order to obtain a straight frequency characteristic. This presumes that the inner resistance of the voltage supply is large compared with the resistance of the recorder. If operated from an amplifier tube, matching by a transformer is difficult due to the very low cutoff frequency required. The recorder, therefore, is connected directly to the anode circuit of a pentode (high inner resistance) and the direct-current anode is compensated. For the type described, the maximum amplitude requires a current of 20 Ma. At a frequency of 700 cycles, the impedance being 6,000 ohms, this corresponds to an alternating-current input of 2.5 watts.

Because of its electromagnetic system, the recorder has some hysteresis, and the recording of absolute quantities is subject to a certain error (about 5 per cent). Therefore, the development of an electrodynamic system was begun.

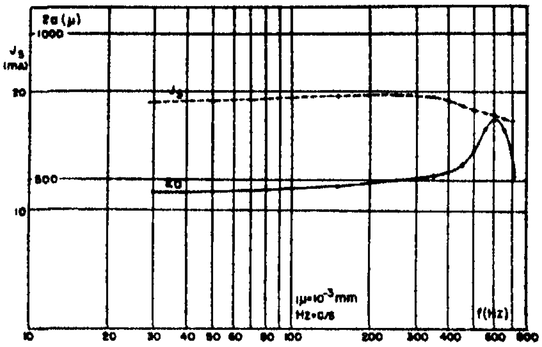

FIG. 3. Electromagnetic recorder: frequency characteristic of the current and of the recorded amplitude.

In Figs. 3, 4, and 5 the frequency and amplitude characteristics of the electromagnetic and electrodynamic systems are compared.

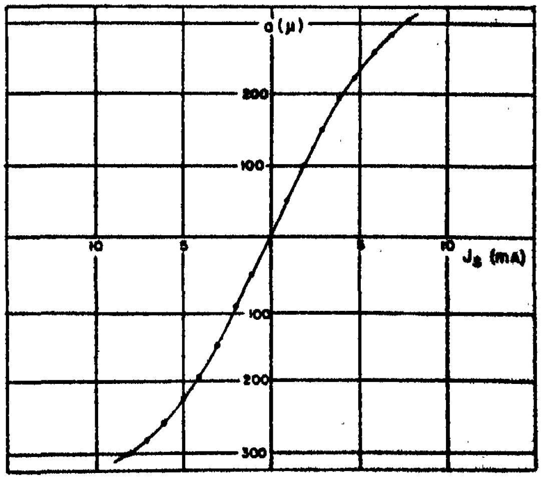

FIG. 4. Amplitude characteristic of the electromagnetic recorder.

Since the development of the electrodynamic recorder is not complete, its frequency characteristic cannot be given. It is probable that it will be linear and in the range from 0 to 250 cycles.

In order to obtain a sufficiently narrow groove, the point of the stylus should have a radius of curvature of about 0.01 mm. It must be resistant to abrasion but should not be so hard as to scratch the glass surface (tungsten). Since such a radius of curvature cannot be produced by a machine, the needle is made by a chemothermal process.

The first experiments were carried out with a disc of sooted glass. The resulting grooves had a thickness of 0.05 mm., despite the fact that the stylus used had very fine points, because the soot was removed in clinging flakes. The requirements which the coating must meet are: homogeneity (no crystal formation), pliability (minimal effect upon the amplitude and frequency characteristics of the recorder), sufficient opacity of very thin layers, and fine tracings during recording.

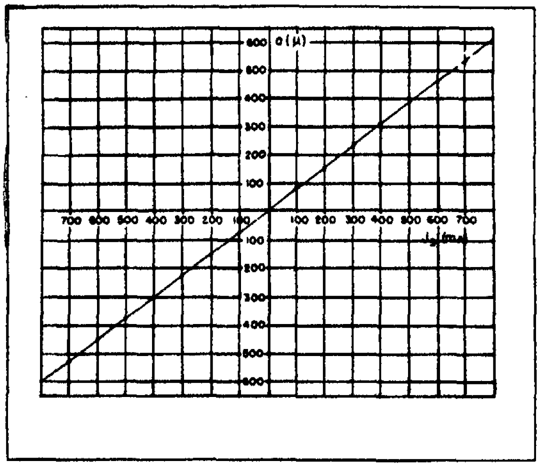

Fig. 5. Amplitude characteristic of the electrodyne recorder.

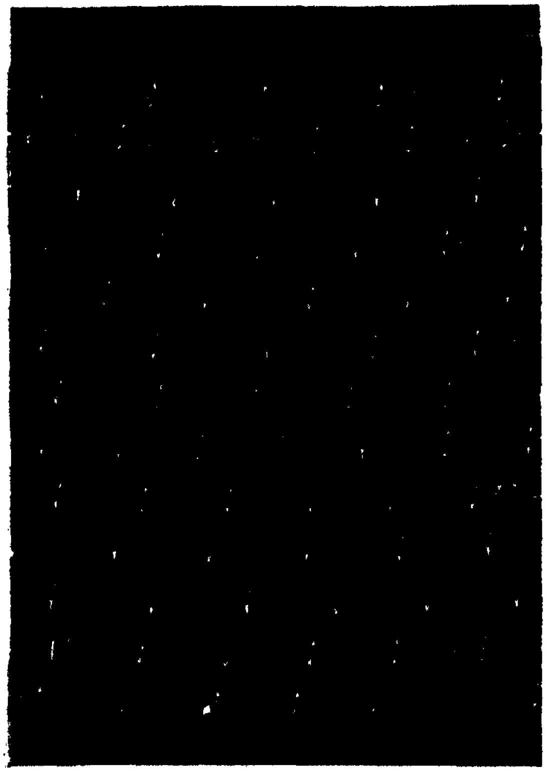

Fig. 6. Photomagnification of a part of an electrocardiac record.

After several trials with pigmented albumin, gelatin, and paraffin coatings, a pigmented and desiccated solution of soap proved most appropriate. The tungsten point mentioned produces a groove 0.01 mm. thick in the soap. At an amplitude of 0.5 mm. the capacity of customary oscillographic methods is exceeded considerably. Not every soap is suitable for this purpose. The best results were accomplished with an American soap; the reason for this is now being investigated.

Discs of plate glass 30 cm. in diameter and 8 mm. thick were used as recording material. The disc should have an absolutely smooth surface, since even fine scratches damage the stylus. The manufacture of recording material is practicable and simple with the standard laboratory outfit. The cost is low, since the discs may be reused indefinitely.

Fig. 6 shows an electrocardiogram obtained with the method described above. The disc rotated constantly at 0.25 r.p.m. so that points on two adjacent grooves lying on the same radius represent events occurring 4 minutes apart.

This new electromechanical method of oscillography, although developed primarily for medical use, may, of course, be applied to other fields. Technical details of its development will be given in a later report.

Experimental Production of Anti-Rh Sera by the Use of Human Erythrocyte Stromata

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It was shown by Landsteiner and Wiener (*3*) that erythrocytes of *Macacus rhesus*, when injected into rabbits or guinea pigs, will produce an antiserum which, after suitable absorption, reacts with 85 per cent of human Caucasian bloods but fails to react with 15 per cent. Later, Gallagher and Jones (*2*) produced anti-Rh sera of the same specificity by the injection of human Rh+ erythrocytes into guinea pigs. Also subsequently, Wiener and Belkin (*4*) demonstrated that the Rh agglutinogen resides in the stroma of the erythrocyte and that it is of a haptene nature.

It had been shown earlier by Witebsky and Heide (*5*) that the injection of rabbits with boiled stromata of type N human erythrocytes produced sera having a high titer of N antibodies and a low titer of species specific antibodies. Calvin, *et al.* (*1*) have shown that the Rh haptene is probably a lipoprotein and is heat labile. We have inoculated guinea pigs with freshly prepared stromata of Rh+ human erythrocytes and produced antisera which, when absorbed with Rh− red cells until they no longer reacted with the absorbing cells, gave reagents that distinguished between Rh+ and Rh− erythrocytes.

The stromata were prepared by lysing Rh+ red blood cells in distilled water. The suspensions were passed through a Sharples supercentrifuge and the lysate discarded. The stromata were repeatedly washed with distilled water and centrifuged until the wash water was free of hemoglobin. With the resulting pale pink, gelatinous residue guinea pigs were immunized by repeated intraperitoneal inoculation. One week or more following the last injection the pigs were bled and the sera separated. After inactivation at 56°C. for 30 minutes the sera were absorbed as indicated above with Rh− erythrocytes. In this way two antistromata testing sera were prepared.

TABLE 1

COMPARATIVE SPECIFICITIES OF Rh TESTING SERA

Commercial anti-Rh$_0$	Antirhesus guinea pig	Antistroma guinea pig No. 516	Antistroma guinea pig Sg	No. of cell specimens
+	+	+	+	79
−	−	−	−	20
+	−	−	−	2
−	+	−	−	2
+	−	−	+	2
+	+	+	−	1
+	−	+	+	1
+	+	−	+	1
+	+	−	−	1
Total				109

The specificities of these sera were determined by testing them against 109 blood specimens chosen at random. For comparative purposes simultaneous tests were also performed with commercial anti-Rh$_0$ serum (Blood Transfusion Betterment Association, New York City) and guinea pig antirhesus serum. The results of these tests are summarized in Table 1.

It is apparent that the stromata of Rh+ human red blood cells can serve as a suitable antigen for the production of Rh testing sera in experimental animals. With the particular stromata used in our experiments sera approximating the specificity of human anti-Rh$_0$ serum were produced. The few divergent results noted in the data may be ascribed to the well-known differences in avidity of some red cells for antibodies in the sera or to inherent reactive characteristics of guinea pig serum.

Some of our other experiments, which are not sufficiently developed to report at this time, suggest that Rh subtype sera may be produced experimentally by careful selection of the cells used for immunization and absorption.

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Book Reviews

Principles of radar. (2nd ed.) Members of the Staff, Radar School, Massachusetts Institute of Technology. New York–London: McGraw-Hill, 1946. 12 Chapters. (Illustrated.) $5.00.

This book was originally written for use as a reference text at the M.I.T. Radar School during the war. Although the second edition has been reworked and brought reasonably up to date, there remains some evidence of the high security classification of radar during the war years. This eliminates much of the most recent work on the subject. The book brings together in one place something of all the important wartime radar developments for the use of students and the numerous technical people who have been kept away from radar activity by other pursuits.

The radar art has grown in the last few years to such an extent that it is not possible in this one volume to cover completely all phases of the subject. For this reason the quantitative details which are necessary to an equipment design are missing, and the field of radar test equipment has been entirely excluded. However, a sufficient description of each technique is included to show its field of applicability.

Advantage is taken of the numerous specialists available to M.I.T. by having a large number of contributors, each in his own field. It is surprising that the tones of the various chapters, written by different authors, have been kept as similar as they have.

In a few instances the authors have made that mistake which is too common with technical writers—the procedure of giving the details of operation of a particular circuit or device without first having given both the purpose of the device and an outline of the fundamental concepts upon which its operation depends. The reader thus finds it necessary to read the exposition at least twice. However, on the whole, this kind of thing has been avoided, and the book has been kept reasonably easy to read. The action of multivibrators, for instance, has been well handled to avoid making this relatively simple device seem complicated.

The early chapters cover an "Introduction" to radar; "Timing Circuits," including ringing circuits, blocking oscillators, and pulse-forming networks; and cathode-ray "Indicators," with the many possible circuits for producing sweep voltages or currents. A chapter is devoted to wide-band "Receivers," their noise problems, and the automatic frequency-control systems necessary at the extremely high radio frequencies sometimes employed. Transmitters are covered by three chapters on "Magnetrons," "Triode Transmitters," and "Modulators." The changes required in these components to obtain short, high-power pulses in packages consistent with the low average power are significant. Separate chapters are provided on "Radio-Frequency Lines" and "Wave Guides and Cavity Resonators" in order to outline the many new techniques in these two fields. An especially long chapter on "Radar Antennas and Propagation" is needed to cover adequately the many forms which highly directive antennas may take. A chapter on "Transmit-Receive Devices" points out antenna-switching methods to permit the use of a single antenna alternately for transmitting and receiving. The text is concluded with a chapter on "Synchros and Servo-Mechanisms" to show, very briefly, how antenna position information may be delivered to suitable indicators and computers.

The book should serve very well in promoting a general knowledge of radar techniques and thus permitting these techniques to receive widespread application in a peacetime world.

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Lectures on the calculus of variations. Gilbert A. Bliss. Chicago: Univ. Chicago Press, 1946. Pp. ix + 296. $5.00.

This book, written by a mathematician who exerted a profound influence upon the modern development of calculus of variations, represents a most significant addition to textbook literature on the highest level. It contains both the fundamentals of the theory and a judicious selection of advanced results. In particular, it contains an integrated exposition of the many significant results that were obtained by the author and his pupils in the problem of Bolza over a period of years.

The book is divided into two parts. Part I, on the simpler problems of the calculus of variations, is concerned with problems in three-space of a relatively elementary character and is comprised of six chapters, as follows: "The Calculus of Variations in Three-Space"; "Sufficient Conditions for a Minimum"; "Fields and the Hamilton-Jacobi Theory"; "Problems in the Plane and in Higher Spaces"; "Problems in Parametric Form"; and "Problems With Variable End-Points." Part II, on the problem of Bolza, is subdivided into the following chapters: "The Multiplier Rule"; "Further Necessary Conditions for a Minimum"; and "Sufficient Conditions for a Minimum." The appendix which follows gives an excellent exposition of the existence theorems for implicit functions and for differential equations that are needed in the theory. The bibliography contains 77 titles, many of which represent the work of members of the Chicago school.

Even though moderate in size, the book contains a very complete account of the field covered. The exposition is uniformly excellent. The decision of the author to begin with a development of the theory in three-space is a wise one. The plane case is deceptively simple in many ways and, as a first study, is unsuited to prepare the reader for the phenomena that arise in the general case. The restriction to simple integral problems is justified, perhaps, for the opposite reason. Indeed, double integral problems present so many distressing features that the enthusiasm of the beginner may not survive the initial shock. Analogous remarks apply to various other topics that are not discussed in detail in the book. The so-called direct method, for example, involves an excessive amount of the general theory of functions of real variables, and the specific features that make calculus of variations such a fascinating study may become obscured thereby in a first introduction to the field. In view of the fact that the author contributed a beautiful study of several important special problems in an earlier volume (*Calculus of variations*, in the Carus monograph series), the lack of applications in the present volume is also justified, even though the reviewer had welcomed some further detailed studies of classical variation problems (for example, the isoperimetric problem on surfaces of constant curvature).

The reviewer feels that the book fills a very definite need in a very admirable manner. It is indispensable for those who wish to study or teach the subject.

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Scientific Book Register

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Mechanism of the Invasiveness of Cancer

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DURING THE LAST SEVERAL YEARS AN attempt has been made in this laboratory to arrive at an explanation of the invasiveness characteristic of malignant tumors. In contrast to benign tumor cells, which remain restricted to their site of origin, malignant cells have the ability to infiltrate adjacent tissues and thus become locally disseminated. Furthermore, their capacity for invasiveness allows them to penetrate into the lumina of lymphatic and blood vessels, whereby they are transported to more distant parts. It was thought that physical and chemical differences must exist between benign and malignant neoplastic cells which permit the former to remain localized and the latter to permeate adjacent normal tissues.

Under the assumption that these differences between the types of cells were ascertainable by experimental methods, a series of investigations was made.[1]

THE DECREASED ADHESIVENESS OF CANCER CELLS

It was demonstrated by the writer (*Cancer Res.*, 1944, **4,** 625) that attached pairs of cancer cells could be separated from each other by micromanipulation, through the application of much less force than was required to separate normal or benign tumor cells. The mutual adhesiveness of the cells was determined by measuring the bend produced in a previously calibrated microneedle when subjected to the strain of detaching one cell from another. Thus, it was found that the mean force required to separate 50 pairs of normal squamous epithelial cells obtained from the lip was 1.42 mg. Similarly the value of adhesiveness for cells from skin papillomata (benign tumors) was 1.25 mg. On the other hand, the mean force necessary to separate 50 pairs of cells from squamous cell cancers of the lip was only one-third this value, or 0.47 mg.

This physical difference between cells of malignant and benign tumors composed of squamous epithelium affords the first requisite for an understanding of invasiveness. It is difficult to visualize any mechanism of invasiveness if tumors are composed of tightly adherent compact masses of cells. However, if the cells are but feebly attached to one another, facilitating complete separation, such separated cells are free to wander into adjacent parts by ameboid movement.

Attempts were then made to find a chemical explanation of reduced adhesiveness. Normal squamous epithelial cells were subjected to various alterations in the chemical composition of the medium in which they were immersed while their adhesiveness was measured. In this way it was shown that absence of calcium from the medium caused reduction in adhesiveness of the cells (*Cancer Res.*, in press). For example, the mean force required to separate 100 pairs of cells in balanced salt solution was 1.34 mg., whereas the value for cells in calcium-free salt solution was only 0.96 mg., a significantly lower value. In this instance, as stated, calcium was absent from the medium surrounding the cells. In another experiment, methylcholanthrene, a substance shown by C. Carruthers and V. Suntzeff (*Science*, 1944, **99,** 245) to reduce the calcium content of epithelial cells directly, was applied to the cells and their adhesiveness measured. Under these conditions also, adhesiveness was reduced.

Since it has also been shown by A. Brunschwig, L. Dunham, and S. Nichols (*Cancer Res.*, 1946, **6,** 233) that cancerous tissue is abnormally low in calcium, and since the investigations just reviewed indicated that adhesiveness of normal cells was decreased when calcium was lowered experimentally, it was concluded that the decreased adhesiveness of cancer cells of the squamous epithelial variety is dependent upon their low calcium content.

THE AMEBOID MOVEMENT OF CANCER CELLS

A satisfactory chemical basis for the separation of cancer cells from each other having been found, the only additional requisite for invasiveness is the ability of the detached cells to move; that is, if the cells, no longer bound to each other, are capable of ameboid movement, their penetration of the adjacent tissues is understandable.

In a previous investigation in this series (*Cancer Res.*, 1942, **2,** 618) epithelial cells from human carcinomas were observed in tissue culture. It was found that individual cells frequently became detached from outgrowing sheets or clusters of epithelium and, further, that these detached cells were actively ameboid. Cells were seen to progress, in this way, some distance from the cluster from which they were derived and, by their proliferation, to build up new colonies. These observations confirmed earlier reports by W. H. Lewis and G. O. Gey (*Johns Hopk. Hosp. Bull.*, 1923, **34,** 369) of

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[1] This investigation was aided by a grant from the Cancer Research Division of the Donner Foundation, Inc.

ameboid movement in cells from both sarcomas and carcinomas.

Thus, it can be regarded as established that, once cancer cells have become detached, they are capable of ameboid motion.

THE ROLE OF SPREADING FACTORS

The detached ameboid malignant cell is physically adapted to invasion of surrounding tissues. However, invasion would be facilitated further if the normal tissues were made more permeable to the cancer cells. This suggested the hypothesis that malignant tumors contain spreading factors, such as hyaluronidase, which, by softening the intercellular cement substance of adjacent normal tissues, render these tissues more susceptible to penetration by the cancer cells (*Amer. J. med. Sci.*, 1946, **211**, 257).

Experiments designed to test this hypothesis were of two kinds. First, an analysis of human tumors was made to determine whether they contained significantly greater amounts of spreading factors than did normal tissues (*Cancer Res.*, in press). Extracts were made from a variety of normal and tumor tissues by grinding, freezing, and thawing the tissue and extracting it with sodium acetate. The acetate extract was used for the assay of spreading factor.

Two methods of assay were employed. By one method, the effect of the tissue extracts upon the spread of hemoglobin in the rabbit skin was determined. The other method depended upon measuring the reduction in viscosity of hyaluronic acid, the substrate upon which the enzyme, hyaluronidase, acts. By these methods it was found that several of the malignant tumors examined did contain spreading factors. In most instances the spreading factor content was not great, and in some it was lacking. When considering the presence of spreading factors in malignant tissues, it must be emphasized that the source of the spreading factors within the tumors has not been determined. It is possible that hyaluronidase was present in certain tumors because of infection by bacteria which were the source of the enzyme. If this is the only source of hyaluronidase in malignant tissue, then its presence is coincidental, even though it conceivably operates to facilitate invasion by the tumor cells by rendering the adjacent tissues more susceptible to penetration. It has yet to be demonstrated that the cancer cell itself contains hyaluronidase. Regardless of the ultimate source of the spreading substance, our analysis of human tumors revealed, in several instances, significant amounts obtainable from the tumors, so that support is lent to the hypothesis that spreading factors may facilitate the invasiveness of cancer cells.

In the second set of investigations, hyaluronidase was injected into transplantable sarcomas in mice, and into virus-induced papillomata in rabbits (*Cancer Res.*, in press). The object of these *in vivo* experiments was to determine whether an excess of hyaluronidase would increase the invasiveness of tumors. The mouse sarcomas were invasive and metastasized to the lungs. It was thought that if hyaluronidase increased the invasiveness of these sarcomas, there would be earlier fixation of the tumors to the adjacent normal tissues and an increased frequency of pulmonary metastases. Neither indication of augmented invasiveness was demonstrable. The rabbit papillomata are primarily benign tumors which may become malignant in some instances when allowed to grow for a long time. It was thought that local injection of hyaluronidase might increase the incidence of malignancy, as judged by invasiveness and distant metastases. Again, confirmative evidence was not obtained. The negative results in these experiments force the conclusion that spreading factors of the hyaluronidase type, though they may be found in malignant tumors, are not essential to invasiveness. The mouse tumors, for instance, were strongly invasive to start with, and their invasiveness apparently could not be enhanced by an excess of hyaluronidase experimentally introduced.

In these *in vivo* experiments, in which spreading factor was injected into the animals daily over long periods, the formation of antienzymes must be considered. Such antienzymes, which inhibit the action of the enzyme on its substrate, have been reported by E. Haas (*J. biol. Chem.*, 1946, **163**, 63, 89, 101), and it will be necessary to await further developments in this field before better-controlled experiments can be designed.

The concept of invasive growth that has resulted from the experiments summarized above depends upon a triad of factors:

(1) Decreased adhesiveness of cancer cells, dependent upon local calcium deficiency. Decreased adhesivenss facilitates the separation of cells from each other so that they become detached units.

(2) Ameboid movement, by which the malignant cells are enabled to wander into the surrounding parts to establish new colonies.

(3) Liberation of spreading factor (hyaluronidase), which acts upon adjacent normal tissues. Hydrolysis of the hyaluronic acid of the intercellular cement substance of connective tissue opens the tissue spaces for penetration by the malignant cells. It is quite possible that this third factor is not requisite for invasive growth, but that when it does operate, it augments the facility with which invasion occurs.

Of the three factors the first two are of greater importance for invasive growth. It is of interest in this regard that the most invasive of all normal cells, macrophages, polymorphonuclear leucocytes, and lymphocytes, are all detached cells, rarely showing any evidence of mutual adhesiveness and all having great ameboid activity. The cancer cell possesses these same attributes, coupled with its capacity for unlimited proliferation.

Artificial Radioactive Tracers:

Applications to Chemistry and Medicine

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ABOUT 450 INDUCED RADIOACTIVITIES are now known, there being at least one radioactive isotope for each of the elements of atomic numbers 1 to 96, inclusive. The work in connection with the Plutonium Project of the atomic bomb development has given rise to vastly superior methods for the large-scale production of a number of these isotopes and, in particular, a number of the most important ones. The outlook at the present time, therefore, is a very optimistic one, with almost unlimited possibilities for research. It is not at all out of the question that the greatest gains to humanity from the atomic energy development will result from the widespread use of tracers to solve a multitude of problems rather than from the harnessing of the power itself.

The present discussion will be concerned entirely with the induced radioactivities, because these now far surpass in importance the natural radioactivities for application in the atom-tagging field. The natural radioelements have been used as indicators or tracers in physical and chemical investigations for about 35 years, the first experiments having been performed by G. Hevesy and F. A. Paneth, but these early investigations were limited to those few elements which have naturally occurring radioactive isotopes. After the discovery of artificial radioactivity, the principle of investigation by "atom tagging" was extended at once to these new activities.

Immediately following the discovery of artificial radioactivity, a large addition to the list of radioactivities was made during 1934 and 1935 as the result of the work of E. Fermi and his associates, who produced unstable isotopes by neutron bombardment of the elements. Also, many radioactivities were produced by several other groups of workers, mainly as the result of bombardment with high-speed charged particles from artificial sources—in particular, bombardment with high-speed charged particles such as protons and deuterons, which were accelerated in various types of high-voltage apparatus.

Following this early work with these many types of particle acceleration apparatus and until recently, the main source for the production of radioactivities was the cyclotron, the use of which added hundreds of isotopes to the total and resulted in the production of very intense radioactivities. However, this did not result in the transmutation of weighable amounts of isotopes.

The Uranium Pile

The recent accomplishment of the self-sustaining nuclear reaction in uranium marks another milestone in the field of artificial radioactivity. In addition to producing new isotopes, the chain-reacting units have increased by many orders of magnitude the amounts of the radioactivities which can be made available. As is now well known, the uranium chain-reacting units, called "piles," have given rise to the transmutation of elements on a weighable scale—in fact, on a scale not only of micrograms, milligrams, or grams but even of kilograms in some cases.

The fission product elements, *i.e.* the radioactive isotopes in the region of atomic numbers about 35 to 60, inclusive, are available in tremendous amounts. The pile, as a powerful neutron factory, also makes it possible to produce important amounts of practically any radioactive isotope which can be produced by neutrons; and, since almost all the important known isotopes can be produced by neutron irradiation, this means that in the future practically all such isotopes should be available in huge intensities. In a recent announcement from the headquarters of the Manhattan Project it was disclosed that a large number of such radioisotopes are now available for distribution to research men through qualified research institutions. A complete description of the available isotopes, their method of production, and the form and quantity in which they are available, together with a description of the organization for their allocation and distribution has been published (*Science*, June 14, 1946).

In the near future there will also be available other devices which will give rise to other milestones in the field of transmutation. Among these are the betatron and the synchrotron, with which it will be possible to accelerate electrons to the energy region of hundreds of Mev and, hence, to produce electromagnetic radiation of this energy. Also, the new 184-inch giant cyclotron at the University of California, Berkeley, is ready for operation. Using the new frequency modulation principle in order to compensate for the relativistic increase in mass at these tremendous energies, this instrument generates

Based on an address delivered before the Conference on the Future of Nuclear Science, Princeton University Bicentennial, September 24, 1946.

deuterons at 200 Mev and helium ions at 400 Mev of energy. These instruments should give the means for further study of fundamental particles, such as the mesotron, for production of new fundamental particles, and give rise to entirely new nuclear reactions. For example, from nuclei which have been bombarded with particles and radiation of this energy, there will come a literal shower of neutrons and protons—for example, a dozen or more at a time—and possibly in some cases even nuclei with mass below that of the heaviest region will undergo fission and give rise to their own groups of fission products. The use of these instruments will undoubtedly add to the list of induced radioactivities.

ARTIFICIAL ELEMENTS

One of the most important and interesting uses to which artificially induced radioactive isotopes have been put has been the investigation of the properties of those elements which do not exist in nature. In most cases so far, this type of chemical investigation has used a "tracer" technique (see *Science*, October 25, 1946, p. 379). The most spectacular examples of its application lay in the discovery and study of the chemical properties of *new* elements nonexistent in nature, *i.e.* the transuranium elements of atomic numbers 93, 94, 95, and 96. Element 93 (neptunium) was discovered in May 1940; element 94 (plutonium), late in the same year (see *Science*, October 25, 1946, pp. 379–380). In the case of plutonium, a long and complex process for its separation from uranium and fission products was to a considerable extent worked out before anyone had ever seen any plutonium even under the microscope. These studies have also led to the elucidation of the electron structure of the heaviest elements, the evidence indicating that these form a series of actinide elements, the added electrons for most of the 14 successive elements starting with thorium going into the 5f, an inner electron shell, similar to the addition of successive electrons to the inner 4f shell in the case of the 14 previously known lanthanide earths.

The experiments of Seaborg, R. A. James, L. O. Morgan, and A. Ghiorso in the Metallurgical Laboratory at the University of Chicago have recently led to the identification of isotopes of elements 95 (americium) and 96 (curium), making it possible to study the chemical properties of these elements by the tracer technique.

In the meantime it has been possible to produce neptunium and plutonium in weighable amounts in the chain-reacting piles. The isotopes which have been produced in this manner are the neptunium isotope of mass 237 and the famous plutonium isotope of mass 239, which is so important in the atomic energy field. With these it has been possible, using the methods of ordinary chemistry, to extend greatly the knowledge of the chemical properties of these elements.

There are also a number of lighter elements which are now known to be extremely rare or nonexistent in nature, but whose chemical properties have, nevertheless, been rather well defined as the result of their production by artificial means and the investigation of their properties by the tracer technique. Many experiments have been performed with unweighable amounts of these elements, which have atomic numbers 43, 61, 85, and 87.

C. Perrier and E. Segrè were able to show in 1937 that the deuteron bombardment of molybdenum produces radioactive isotopes of element 43, and they used these to study its hitherto unknown chemical properties. This is particularly interesting from an historical point of view because this is the first of the artificial elements to be discovered. Their experiments showed that the chemical properties resembled those of the heavier homologue, rhenium, to a much greater extent than they resembled those of manganese, the lighter homologue. These investigators used rhenium as carrier for the radioactivity in order to show that element 43 is precipitated by hydrogen sulfide from alkaline or acid (less than 10 N) solution. They investigated other properties, including the volatility of the oxide and chloride and the conditions for the electrolytic deposition of the metal. Recently R. P. Schuman and also D. C. Lincoln and W. H. Sullivan, working on the Plutonium Project of the Manhattan District, have independently observed the radioactivity (with very long half-life) due to the lower isomeric state of 43^{99}, formed in the fission of uranium. This is interesting because it is now possible to isolate this isotope in weighable amounts. This particular isotope of element 43 was discovered by Segrè and Seaborg, who produced it from the deuteron and neutron bombardment of molybdenum and found that the upper isomeric state has a half-life of 6.6 hours and the lower, one of more than 40 years. The discoverers, Perrier and Segrè, have suggested the name "technetium" (Tc) for element 43, and it seems certain that this name and symbol will be adopted.

A radioactive form of element 61 has been positively identified in the experiments of J. A. Marinsky, L. E. Glendenin, and others, on the Plutonium Project of the Manhattan District, who found that isotopes 61^{147} and 61^{149}, with half-lives of about 3.7 years and 47 hours, respectively, are formed in the fission of uranium. This element is a rare earth, and the chemical experiments on the tracer scale show that its behavior is very similar to that of the preceding element, neodymium. Experiments involving selective adsorption and elution on ion-exchange resins led to the unambiguous separation of the element from its neighbors. The availability of isotope 61^{147} in large amounts from fission makes it now possible to isolate the missing element 61 in weighable amounts, and I am confident that this will soon be done. The name which is to be eventually adopted for element 61 should be, and presumably will be, the one which Marinsky and Glendenin will suggest.

The discovery of radioactive element 85 (isotope 85^{211})

from bismuth plus 32-Mev alpha-particles, by D. Corson, R. Mackenzie, and Segrè, made it possible for these workers to investigate its properties. The general behavior is that of a metal, with little resemblance to the other halogens. It is precipitated by hydrogen sulfide in 6 *N* hydrochloric acid solution with various carriers, and the sulfide is insoluble in ammonium sulfide. Volatility at comparatively low temperatures is observed; a piece of bombarded bismuth loses most of the activity before melting (275°C.). There is no precipitation upon the addition of silver nitrate to a dilute nitric acid solution using iodide as carrier. These investigators have given the name "astatine" (At) to this element.

A radioactive form of element 87 resulting from the alpha branching decay of actinium has been discovered by M. Perey in France. This isotope, given the name AcK, has the mass 223 and decays by negative beta-particle emission with a half-life of about 21 minutes. The experiments of Perey have shown that the element behaves, as expected, like a heavy alkali metal; for example, it is carried by the compound, cesium perchlorate. Perey has given it the name "francium" (Fa).

Perhaps the most extensive application of the artificial radioelements in chemical work has been to the study of "exchange reactions." In exchange experiments the atoms of an element in one of its valence forms or types of chemical combination are labeled by admixture with some radioactive isotope of the element which is of the same form or chemical combination. To this system is added the element in another state of valence or form of combination, containing none of the radioactive isotope; the presence of radioactivity in this second chemical form, after it has been separated from the first, shows that an effective exchange of atoms between the two different states of the element has taken place. Experiments of this type give information on chemical bond types, the strength and reactivity of chemical bonds and the effect of solvents on these properties, the structure of ions and compounds, the mechanism of reactions, and the mechanism of catalysis. In addition, exchange reactions often offer an excellent and convenient method for the introduction of radioactive atoms into compounds.

The subject of exchange reactions is too complicated to make possible accurate, complete generalizations. It seems profitable, however, to make a few rough statements concerning homogeneous exchange reactions. If we consider exchanges of a given element between two sorts of molecules or ions in which it is held by electron-pair bonds to different numbers or kinds of other atoms, we may say in general that such exchange reactions do not proceed with appreciable rates except in those cases where there are reversible reactions which enable the exchanging atoms to reach equivalent states of chemical combination. For example, there is no exchange of atoms between phosphate and phosphite ions, sulfate and sulfite ions, sulfur and carbon disulfide, iodide ion and iodoform, etc. On the other hand, exchanges have been found between chloride and chlorate ion (due to the oxidation-reduction equilibrium), between lead nitrate and lead chloride (an extreme example of the ionization exchange mechanism), and between iodide ion and iodine (through the formation of a symmetrical intermediate, I_3^-). When the two exchanging molecules differ only in their net charge, another exchange mechanism—the transfer of an electron from one to the other—may become possible. For example, exchanges have been observed between Fe^{++} and Fe^{+++} and between MnO_4^{--} and MnO_4^-. It is no doubt true that some exchanges occur through a simple transfer of atoms between molecules during a collision; such a mechanism is a special case of exchange through the formation of an intermediate. In many cases the observation of exchanges of this sort suggests the existence of unstable intermediates which might not be known from other reaction studies.

Probably the most important isotope from the standpoint of future possibilities is the radioactive C^{14}. This isotope, discovered by S. Ruben and M. D. Kamen at the University of California, has a half-life of some thousands of years and therefore, before the advent of the chain-reacting pile, was practically unavailable due to the difficulty of its production in the large amounts needed to produce substantial radioactivities. However, the intense neutron source in the piles makes it possible now to produce C^{14} in such quantity and high specific activity as to place it in a class along with the most available and suitable isotopes. It can be produced in either of two ways: the neutron irradiation of carbon, preferably enriched C^{13}, by the reaction $C^{13}\,(n,\gamma)C^{14}$, or the neutron irradiation of nitrogen by the reaction $N^{14}(n,p)C^{14}$. Both of these reactions take place with slow neutrons. The reaction with nitrogen is, of course, preferable from the standpoint of producing C^{14} of the highest specific activity, it being, in fact, possible to produce isotopically pure C^{14} in this manner. The radiation is of relatively low energy, making it necessary for its detection to employ instruments designed with this in mind, and, in the investigations, to pay close attention to the self-absorption problem.

A whole vista of opportunity is, of course, opened as a result of the availability of the C^{14} isotope. Organic chemists, biochemists, physiologists, and men of medicine have dreamed for years of the day when a radioactive isotope of carbon suitable for tracer investigations should become available. A few of the possibilities which have opened through its availability will be indicated presently, but this field is so vast that it is certain that the best ideas are yet to come.

A great deal has been said in comparison of the potentialities of radioactive C^{14} and the separated stable C^{13} in these fields. Actually, these isotopes complement each other, and it is very fortunate that both are available. There now exists the interesting possibility of tagging each of two different carbon atoms in a molecule or system and then *simultaneously* observing the course of each. Also, the separated C^{13} makes possible the production of radioactive C^{14} of higher specific activity from the reaction $C^{13}(n,\gamma)C^{14}$.

Another isotope which has great potentialities is the radioactive H^3, which has a half-life of about 30 years. This can be used in many of the ways indicated for the use of C^{14} if it is present in a molecule in a nonlabile position. The availability of the intense neutron sources makes possible its production in weighable amounts by means of the reaction $Li^6(n, \alpha)H^3$. The radiation consists of extremely low-energy beta-particles, and therefore its detection demands the use of very special instruments, it being necessary to introduce the material in the form of a gas into the inside of the Geiger-Müller counter, ionization chamber, or electroscope.

Besides radioactive C^{14} and H^3, such isotopes as the 14.3-day P^{32}, the 87-day S^{35}, the 180-day Ca^{45}, the 47-day Fe^{59}, the 250-day Zn^{65}, the 53-day Sr^{89}, the 8.0-day I^{131}, and many others have offered and will offer many opportunities for important research.

The first and most obvious application in organic chemistry for C^{14} would be in an examination of the mechanisms of many isomerizations and rearrangements of organic molecules. There are a number of reactions in which carbon atoms or groups of carbon atoms move from one part of a molecule to another, and the question of just how this migration is accomplished has been a subject for discussion among organic chemists for many years. By labeling the migrating groups in certain positions it should be possible to determine the precise sequence of events in such a reaction. In many types of rearrangments it is impossible to tell, by ordinary means, which carbon atoms are actually migrating. It is easy to see how, by a selective labeling of atoms, an unequivocal answer to these questions is obtained.

Not only is this type of information of interest for itself and the light it will throw upon the behavior of organic substances, but it is a necessary preliminary to the synthesis of tagged compounds of biological interest and to the examination by degradation of metabolic products derived from administered labeled materials.

It is in this latter field of biochemistry that the carbon isotopes will have their greatest usefulness. The determination of the intermediary metabolism of the major structural and energy-transforming materials of living organisms such as fats, proteins, and carbohydrates, as well as the catalytic or organizing substances such as vitamins, hormones, and enzymes, will undoubtedly make great strides as a result of the availability of isotopic carbon and some of the other isotopes as well.

Turning to biological systems, we find a virtually unlimited field of important work for the organic chemist and workers in all branches of biology.

It is not out of the question that a complete understanding of the photosynthetic mechanism might give men the ability to synthesize food and fuel at will, using this principle. This could give rise to a literal harnessing of the sun's energy. With the aid of C^{14} this might be accomplished. A number of experiments have been performed with the 21-minute C^{11}, but this short half-life placed definite limits on the extent of progress which was possible. Nevertheless, Ruben, Kamen, and W. Z. Hassid were able to use radioactive C^{11} in a study of photosynthesis in which considerable progress was made. Radioactive carbon dioxide was fed to the unicellular green alga, *Chlorella,* and also to higher plants under various controlled conditions in both the light and the dark. The results obtained so far have been quite interesting. The higher plants and the algae absorb carbon dioxide in the dark. This process takes place concurrently with the release of CO_2 by respiration, so that the net effect is an evolution of carbon dioxide. Only by the tracer technique was it possible to demonstrate a simultaneous uptake and evolution of carbon dioxide. The dark uptake of carbon dioxide is very likely the first step in photosynthesis and can be represented by $RH + CO_2 \rightleftharpoons RCOOH$. Decarboxylation experiments have shown that the bulk of the radioactive carbon is in the carboxyl group. Attempts to identify the radioactive substances formed in the dark and in the light have been thus far unsuccessful. It is of considerable interest to note that formaldehyde, which has played a prominent role in many proposed mechanisms, was not identified from the radioactive carbon dioxide introduced. Experiments with the ultracentrifuge and diffusion methods indicate the average molecular weight of the radioactive molecules to be about 1,000, which explains the failure to identify them chemically with any small molecules.

The radioactive elements, in particular radioactive carbon, will, of course, receive widespread use in studying animal metabolism. In the highly intricate process of carbohydrate metabolism in man, present knowledge has been gained, for the most part, only as a result of painstaking analytical work by classical methods. In general, these methods are not capable of high precision and are not adapted for the determination of highly labile compounds. Thus, it is quite likely that many important details of the process under investigation have not been revealed. Almost certainly, the use of radioactive tracers will bring these details to light. Aside from circumventing many analytical difficulties, the use of labeled elements can yield important information not possible by other methods. It is very often the case in biological systems that reactions proceed under steady-state conditions. With radioactive tracers it is possible to follow the formation of a compound in the presence of a considerable amount of the previously synthesized compound or to measure synthesis while the net reaction constitutes breakdown. Such measurements will be of great value in determining the mechanisms of biological reactions. For example, B. Hastings and his collaborators at Harvard have used C^{11} in the study of glycogen formation in the liver and have found that the incorporation of carbon dioxide into organic molecules takes place here. Many carbon dioxide-incorporating reactions have been studied with C^{13} by H. G. Wood and C. H. Werkman. The present availability of C^{14} will make possible the elucidation of many mechanisms in the metabolism of carbohydrate and fat. Many biologists believe that artificial radioactivity has given biology and medicine what is probably the most useful tool for research since the discovery of the microscope, because almost all of the elements and compounds in biological systems can be tagged and their course through living systems studied.

The most simple and direct use of an element as a tracer is accomplished by its administration as a simple inorganic compound, in which case the distribution of the tagged element in the various structures of the plant or animal is determined by measuring the radioactivity of the samples of tissues and body fluids. A very large number of experiments of this type have been performed, principally to aid in the understanding of mineral metabolism. For example, the absorption of iron as related to anemia has been studied by G. H. Whipple and P. F. Hahn at the University of Rochester.

Radiophosphorus has been the most widely used of all the artificially prepared radioelements as a tracer for metabolic studies in biological systems. The distribution of administered phosphorus in human and animal tissues has been extensively studied. It has been observed, for example, that the retention of a single dose of disodium phosphate varied in different tissues in the following decreasing order: bone, muscle, liver, stomach plus small intestines, blood, kidneys, heart, lungs, and brain. In other experiments a selective accumulation of radiophosphorus in leukemic tissues was found to occur. This was important in that it indicated that the leukemic tissues could be subjected to a greater degree of beta-particle irradiation than the normal tissues, which in turn indicated the application of radiophosphorus as a potentially valuable therapeutic agent.

The synthesis of the biologically important organic phospholipids has been studied by G. Hevesy and co-workers in Copenhagen and I. L. Chaikoff and his associates in California. Compounds like these are now considered to be vital links in the complex, low-temperature oxidation mechanisms characteristic of living systems. Chaikoff and associates have shown the importance of the liver in such synthesis and transport: how the turnover of these substances through the liver can be altered by the administration of choline and certain amino acids and how newly synthesized molecules are absent altogether from the blood when the liver is removed. Using surviving tissue slices, they have demonstrated the dependence of the synthesis upon the proper functioning of certain respiratory enzyme systems. The first real insight into the mechanism of the action of insulin on carbohydrate metabolism has come from studies, by J. Sacks at Michigan with P^{32}, on the effect of this hormone on the turnover of phosphorus compounds in muscle. All of these studies, of which only a few were mentioned, would have been impossible without the use of a labeling agent.

Extensive metabolic studies have been made with the use of radioactive iodine as an indicator. The pioneering work in this field was done by S. Hertz and his co-workers in Boston and J. G. Hamilton and co-workers at California. The thyroid gland, through its synthesis of the iodine-containing hormone, thyroxine, controls the metabolic rate of the entire organism. Nevertheless, the quantities of iodine compounds produced and distributed are so small that even the finest micromethods are hardly adequate for the task of studying these processes. With the use of radioactive iodine the analytical difficulties can be largely overcome, and, in addition, types of measurements can be made which are not possible from chemical analysis. Among these is the measurement of the uptake of orally administered radioiodine by the intact thyroid glands of normal human subjects and by those of patients suffering from various types of thyroid disorder. The course of the uptake may be followed simply by placing a Geiger counter in the vicinity of the throat. The thyroids of patients with hypothyroidism were shown to accumulate iodine at a slow rate, while there was a relatively large uptake of administered iodine in the thyroid glands of patients with nontoxic goiters. In contrast to these behavior patterns, the thyroids of patients with hyperthyroidism were shown to take up administered radioiodine at a remarkably rapid rate and also to discharge the iodine from the gland in a rapid fashion. It is seen from these studies that an aid toward diagnosing the condition of the thyroid gland is available.

A large amount of work on iodine metabolism has been done by Chaikoff, I. Perlman, and M. E. Morton at the University of California. They were able to follow in some detail the distribution of organic iodine compounds from the thyroid gland through the blood to peripheral tissues in various states of thyroid activity; to demonstrate that, to a limited extent, tissues other than the thyroid gland are able to synthesize thyroxine; and, by using isolated surviving tissues, to tie in the synthesis of an organic compound with the energy-producing enzyme systems.

B. C. Smith and E. H. Quimby at Columbia have used the gamma radiations from intravenously injected $Na^{24}Cl$ to determine the rate of passage of sodium into the extracellular phase of the tissues in cases of peripheral vascular disease and thus determined the competency of the circulation—another example of use for diagnosis.

Many more possibilities for the use of radioactive isotopes in biochemical and physiological work might be suggested, but those given above are typical.

The study of the mechanism of action of antibiotic substances, many of which act by means not completely understood at present, will be possible. For example, the synthesis of radioactive penicillin or streptomycin might give rise to a method for investigating the mechanisms by which these great substances operate. The mechanism of action of antibodies might also be investigated by the use of tracers.

Another possible use of tracers is, of course, in the study of cancer. Here, in addition to the possibilities cited in connection with the use of radioactive indicators in the investigation of mechanisms, there is the therapeutic possibility of effecting the selective deposition of the radioactive material in the cancerous tissue, as has been mentioned in the case of leukemia. It has occurred to many investigators that it should be possible in the future to synthesize some compound containing a radioactive substance, this compound having the property of being selectively absorbed by the cancerous tissue so that the radioactive rays can act directly at this spot without harmful effects on the body's healthy tissue.

Another possibility, which may sound quite startling, is that of tagging bacteria with radioactive C^{14}. This appears to be feasible and to open great possibilities in the study of disease. In fact, Chaikoff and A. Kaplan have made a beginning by tagging the tuberculosis bacillus with radioactive phosphorus in some experiments which have not yet been brought to completion.

In addition to the therapeutic uses of radioactive substances which have already been mentioned, therapeutic value has been established in the work of J. H. Lawrence and associates, who have had some success in the application of radioactive P^{32} to the temporary control of the blood diseases, polycythemia vera and leukemia. A large number of other therapeutic uses will surely be found, since it will be possible to apply alpha-particles, beta-particles, and gamma-rays to this purpose. It is worth pointing out that all of these radiations are represented in isotopes which can be produced in quantity, so that it is quite likely that the use of radium and its descendants in this type of therapy will soon be superseded by the artificial radioactive elements.

Availability of large quantities of radioactivities has also opened the possibility of their use in industry and industrial processes. Radioactive indicators may soon be used to follow the course of products and impurities in large industrial processes. Applications should be found in the testing of the efficiency of distillation apparatus, in testing for leaks, and in many other ways. The intense sources of gamma-rays will find application in the field of radiography, in looking for imperfections in metal products, studying the path of fast-moving parts, etc.

With respect to chemical problems of direct interest to industries, many examples could be cited. Among these may be mentioned studies, with C^{14}, of the mechanism of catalytic cracking, isomerization, and alkylation of hydrocarbons, which are of profound interest to the oil industry.

The future seems to hold unlimited possibilities for the application of radioactive tracers to scientific problems. It is certain that the applications made thus far are just the beginning of what is going to become an extremely large and successful field of research.

Local Committees, Chicago Meeting, AAAS

From April 7 to 9 officers of the AAAS will meet with representatives appointed from the various educational and cultural institutions in the Chicago area to serve on five committees that will direct local preparations for the 114th meeting of the AAAS, to be held in Chicago December 26–31, 1947. These committees, of about 12 members each, will handle problems of reception and entertainment, procurement and distribution of equipment, registration, and publicity, and will help to raise funds to defray expenses incurred by the work of the local committees.

Honorary chairmen, serving in an advisory capacity for the local committees, include: Paul M. Angle, secretary, Chicago Historical Society; Charles C. Caveny, dean, Chicago Undergraduate Division, University of Illinois; Walter H. Chute, director, John G. Shedd, aquarium; H. C. Coffman, president, George Williams College; V. R. Edman, president, Wheaton College; H. K. Gloyd, director of Museum, Chicago Academy of Sciences; Clifford C. Gregg, director, Chicago Natural History Museum; Henry T. Heald, president, Illinois Institute of Technology; Robert M. Hutchins, chancellor, University of Chicago; A. C. Ivy, University of Illinois; Paul A. Jenkins, executive secretary, Chicago Technical Societies Council; K. Richard Johnson, head of Science Department, National College of Education; T. Lehmann, president, Elmhurst College; L. R. Lohr, president, Museum of Science and Industry; Lee Medsker, dean, Wright Junior College; Comerford J. O'Malley, president, De Paul University; Franklyn B. Snyder, president, Northwestern University; Edward J. Sparling, president, Roosevelt College.

The Chicago Convention promises to be one of the largest on record. At least 60 affiliated and associated societies and sections are planning to meet with the Association.

NEWS *and Notes*

A new location for the Argonne National Laboratory for research and development in atomic energy, and acquisition of 3,645 acres of land in Du Page County, Illinois, were approved recently by the U. S. Atomic Energy Commission. The site is approximately 26 miles southwest of the center of Chicago, and 4 miles west of facilities of the Laboratory in the Palos Area of Cook County Forest Preserve.

Argonne National Laboratory was established for research and development in all phases of atomic energy, including fundamental research in physics, chemistry, biology, medicine, and engineering; the development of industrial power; and research on military uses.

Artist's sketch of proposed facilities of the Argonne National Laboratory.

Present facilities of the Laboratory are housed in four buildings on the campus of the University of Chicago, the Museum of Science and Industry, and the Palos Area of Cook County Forest Preserve. Operating difficulties due to wide dispersion of facilities were apparent early, and a permanent site was sought. The Board of Governors of Argonne National Laboratory, of which Farrington Daniels is chairman, chose Chicago as the permanent site because of its geographical location and transportation advantages.

Prime consideration in the search for a permanent location was engineering features of the land. Topography, prevailing meteorological conditions, type of foundation, and available water, sewage, and power facilities were considered, and the Du Page County site was the only area investigated which satisfied all requirements. In addition, its proximity to the present Forest Preserve site will allow maximum use of facilities there during the transition period.

"Construction plans for the permanent buildings of the Argonne National Laboratory," Walter H. Zinn, director, said, "call for some 12 major buildings to house administration; physics, chemistry, biology, medical and engineering research; nuclear reactors and allied equipment. Construction will be spread over a period of approximately three years."

Argonne Laboratory, one of a projected series of national laboratories, is successor to the wartime Metallurgical Laboratory of the Manhattan Engineer District. Its facilities are operated by the University of Chicago under contract with the Atomic Energy Commission. The Board of Governors of the Laboratory, comprised of 7 representatives elected by the Council of Participating Institutions—midwestern academic and research institutions—reviews matters of general policy and makes necessary recommendations for submission to the Contractor and the Government. A representative from each of the 25 participating institutions serves as a member of the Council.

The participating institutions are: Battelle Memorial Institute, Carnegie Institute of Technology, Case School of Applied Science, Illinois Institute of Technology, Indiana University, Iowa State College, Mayo Foundation, Michigan State College, Northwestern University, Notre Dame University, Washington University, Western Reserve University, University of Chicago, University of Cincinnati, University of Illinois, University of Iowa, University of Michigan, University of Minnesota, University of Missouri, University of Nebraska, University of Pittsburgh, and University of Wisconsin.

About People

James B. Conant, president of Harvard University, delivered a special address to the staff and student body of the University of Texas Medical Branch, Galveston, February 21, on "The Growing Relations of Chemistry and Medicine."

C. L. Bird, lecturer in dyeing at Leeds University, England, has been appointed editor of the *Journal of the Society of Dyers and Colourists* to succeed F. M. Rowe, who died December 8 (*Science*, February 14). Mr. Bird was previously assistant editor of the journal.

Donald Wallace MacKinnon, professor of psychology, Bryn Mawr College, has accepted an appointment as professor of psychology at the University of California, Berkeley, beginning in September 1947.

Laurence H. Snyder, chairman, Department of Zoology and Entomology, Ohio State University, delivered the Marshall Woods Memorial Lecture at Brown University February 18, on "Human Genetics and Public Health."

Peter Gray, professor of biology, was named head of the Department of Biological Sciences, University of Pittsburgh, in February. He has been acting head since February 1946, when O. E. Jennings resigned to become director of the Carnegie Museum.

L. Don Leet, in charge of the Harvard Seismograph Station, was recently appointed professor of geology at Harvard University.

I. S. Ravdin, John Rhea Barton professor of surgery, University of Pennsylvania, will deliver the 14th E. Starr Judd Lecture April 15 at the University of Minnesota, Minneapolis, on the subject, "Changing Concepts in Surgical Care." The late E. Starr Judd, an alumnus of the University of Minnesota Medical School, established this annual lectureship in surgery a few years before his death.

Harold H. Biswell, in charge of range research, Appalachian Forest Experiment Station, Asheville, North Carolina, will join the Department of Forestry, University of California, Berkeley, in May.

Harris M. Benedict recently became senior plant physiologist and **Carl A. Taylor** became research agriculturist for the Natural Rubber Research Project at Salinas, California (*Science*, January 27, 1946). The work is being performed by Stanford Research Institute under contract with the Office of Naval Research as a fundamental study of the genetics and physiology of rubber-bearing plants.

Henry S. Sharp, Department of Geology and Geography, Barnard College, Columbia University, will spend about six months in Japan and the South Pacific Islands as geologist for the Military Geology Unit of the U. S. Geological Survey.

Visitors to U.S.

Honor B. Fell, director of the Strangeways Laboratory, Cambridge, England, spent a week, beginning February 17, at the University of Texas Medical Branch inspecting research studies in the Tissue Culture Laboratory, which is under direction of Charles M. Pomerat. Dr. Fell also participated in developing special tissue culture techniques for the *in vitro* study of cellular enzyme and growth systems.

Hsiao-Chien Chang and **Pao-Chang Hou,** dean of Hsiang Ya Medical College, Changsha, Hunan, China, and professor of pathology, Cheeloo University, Tsinan, China, respectively, were visitors at Duke University School of Medicine November 10–17. As guests of the U. S. State Department they will continue to visit American medical institutions until June 1947. Dr. Chang addressed the undergraduate medical society on "Medical Education in China," and Dr. Hou lectured to the Duke faculty and student body on "Leprosy and Plague" and "Kala-Azar."

Fellowships

Socony-Vacuum Oil Company, Inc., New York, has announced an appropriation of $20,000 to establish 10 annual $2,000 fellowships in chemistry and physics at leading educational institutions.

For the next academic year the fellowships have been awarded to the California Institute of Technology, Harvard University, University of Illinois, Massachusetts Institute of Technology, University of Notre Dame, Ohio State University, Princeton University, Rice Institute, University of Wisconsin, and Yale University.

Recipients, who must have at least one year of graduate work, are not required to study subjects connected with the petroleum industry.

Grants and Awards

James Irvin Hoffman, member of the chemical staff of the Bureau of Standards since 1919, was awarded the 1946 Hillebrand Prize in chemistry at a meeting of the Chemical Society of Washington, March 13. Dr. Hoffman was cited for the concept and demonstration of the use of ether in removing impurities from crude uranium, and also for work in a new process of alumina production. The Hillebrand Prize, established in 1925 in honor of William Francis Hillebrand, chief chemist of the National Bureau of Standards from 1908 to 1925, is made each year to a member of the Chemical Society of Washington who has made outstanding contributions to chemistry during the preceding three years.

Pi Lambda Theta, National Association for Women in Education, announces two awards of $400 each to be granted again this year for research on any aspect of the professional problems and contributions of women in education or another field. Three copies of the final report of the completed research study should be submitted to the chairman of the Committee on Studies and Awards, Bess Goodykoontz, U. S. Office of Education, Washington 25, D. C., before July 1.

The Robert Gould Research Foundation of Erlanger, Kentucky, has established 2 grants of $1,500 for student training in nutrition and 10 grants-in-aid of research for 1947–48. The grants-in-aid of $2,000 each will be distributed equally in the following fields: recognition of preclinical nutritional deficiencies; human nutritive requirements; most effective techniques for educating the public in nutrition; improvement in nutritive value of human food as grown; and improvement in the nutritive value of animal food.

Inquiries may be addressed to: Arthur Lejwa, Scientific Director, The Robert Gould Research Foundation, Inc., Cincinnati 2, Ohio.

Colleges and Universities

The California Institute of Technology, Pasadena, has established the David Lindley Murray Education Fund with a gift of $300,000 from Mrs. Katherine Murray, income of which will provide 15 scholarships. Mrs. Murray, with her husband, for whom the fund is named, had been a visitor to Pasadena from Illinois for many years prior to her death in 1944.

The University of Michigan, Ann Arbor, has granted sabbatical leaves of absence to A. D. Moore, professor of electrical engineering, in the 1946–47 spring semester, and Charles H. Griffits, professor of psychology, in the 1946–47 second semester.

Harvard University's engineering laboratories are now testing samples of soil and rock from the Isthmus of Panama in connection with proposals for new canal facilities for ships passing from the Atlantic to the Pacific.

The University has started extensive engineering studies of canal problems in the area to determine the best means of providing for growth of interoceanic commerce and protecting the security of the Nation.

Plans for several locations and types of canals are under consideration, among them addition of a third set of locks to the present canal, conversion of the present lock canal into a sea-level canal, and proposal to dig a new sea-level canal in another part of the Isthmus. Selection of the plan, which will be presented to Congress before the end of 1947, will depend in part on tests to be performed within the next few months at the Harvard engineering laboratories.

Harald M. Westergaard, professor of civil engineering, Arthur Casagrande, professor of soil mechanics and foundation engineering, and L. Don Leet, seismologist and professor of geology, are now engaged in the Isthmian Canal studies. Dr. Casagrande, in charge of the laboratory testing work, has under him William L. Shannon, loaned to the University by the War Department, and Liang-sheng Chen, engineer, who received his Doctor's degree from Harvard. Dr. Leet will be concerned with the effect of earthquake and volcanic activity on any proposed canal structure and the effect of vibrations set up by explosions and their bearing on the angle of slope of canal cuts.

New testing chambers are under design which will subject samples of soil and rock to dynamic forces resulting from explosions of present-day weapons. Electronic measuring devices are employed in a testing chamber known as the triaxial compression apparatus for dynamic loads. A sample of the soil or rock is put into the chamber, which consists of a lucite cylinder with substantial metal ends. Above the sample is a proving ring attached to a piston which exerts a load on the sample. The amount of load reaching the sample is measured electronically through strain gages mounted on the proving ring, and similarly, the amount of deformation of the sample is measured electronically by strain gages on a cantilever beam mounted on the piston. The pressure within the chamber can be raised to simulate conditions at the depths within the earth from which the sample comes.

Summer Programs

The Massachusetts Institute of Technology announces a special summer session in applied mathematics, from August 4 to September 19, in which the following graduate courses will be offered: Theory of Plates and Shells, by F. B. Hildebrand and E. Reissner; Theoretical Hydromechanics, by E. Reissner and C. C. Lin; Advanced Topics in Applied Mathematics, by J. L. Synge, H. Reissner, W. Prager, F. B. Hildebrand, and P. D. Crout; and Tensors in Mechanics, by D. J. Struik.

The Biological Laboratory, Cold Spring Harbor, Long Island, New York, is again offering a course for research workers by Mark H. Adams, of New York University. The course, designed to acquaint scientists with some of the techniques used in research with bacterial viruses and recent results of such work, will be held from June 30 to July 18.

Brown University's Graduate Division of Applied Mathematics will offer a special summer program of instruction in Modern Mechanics of Fluids and Solids with particular emphasis on nonlinear problems, July 7–August 30.

The session, open to advanced graduate students, instructors, and research personnel of government and industry, will consist of two periods, July 7–August 1, and August 5–30. During each period a course in fluid mechanics and another in mechanics of solids will be offered, each course consisting of 20 lectures and 12 discussion periods. Instruction will presuppose a good foundation in classical fluid dynamics and theory of elasticity.

Courses offered will be Dynamics of Viscous Fluids, by Chia-Chiao Lin, Brown University; Theory of Structural Stability, George Francis Carrier, Brown University; Dynamics of Compressible Fluids, Sidney Goldstein, University of Manchester, England; and Theory of Plasticity, William Prager, Brown University.

Inquiries should be addressed to the Registrar, Graduate School, Brown University, Providence 12, Rhode Island.

Industrial Laboratories

A pound and a half of potassium phthalimide containing the "tracer" isotope, Nitrogen 15, and believed to be the largest quantity of an organic compound containing an isotope ever prepared was shipped recently from Rochester to Columbia University in New York.

According to C. F. H. Allen, assistant superintendent of Eastman Kodak's Synthetic Organic Research Laboratory, under whose direction the work was conducted, the Columbia group will convert the potassium phthalimide into special amino acids containing the isotopic nitrogen.

Kodak's concentration of isotopes, begun in 1940, is now being carried out on quite an extensive scale. The work will gradually become a part of the production program which supplies about 3,000 chemical compounds to research laboratories in the United States.

Assisting Dr. Allen in the work on Nitrogen 15 were C. Vernon Wilson and Donald Burness, of the laboratory staff.

Smith, Kline & French Laboratories, Philadelphia, Pennsylvania, announces appointment of Charles H. Fahrenholz, Jr., Grove City College, and George E. Fajcsi, Ohio State University, to its research staff.

The Chemical Research and Development Department, Armour and Company, Chicago, announces appointment of Lawrence L. Lachat, senior fellow at Mellon Institute, Pittsburgh, to direct development of new biochemicals which have become avilable largely as a result of war-time research under contract between Armour and the OSRD.

General Electric Company on March 31 began shipment of the first 100,000,000-volt betatron to be built on a commercial basis. The machine is being built by the Company's General Engineering and Consulting Laboratory for Clinton Laboratories at Oak Ridge, Tennessee. Shipment of final components will be completed by midsummer.

The new instrument for Clinton Laboratories, operated by the Monsanto Chemical Company for the Atomic Energy Commission, will weigh approximately 160 tons, and will be 9 feet high, 6 feet wide, and 15 feet long. General Electric is building a similar instrument for the University of Chicago to be used for nuclear research.

Meetings

The Medical Library Association will hold its 46th annual meeting in Cleveland, Ohio, May 27–29, at the invitation of the Cleveland Medical Library Association, with headquarters at the Wade Park Manor.

In addition to scientific sessions on May 27–28, a symposium, "Visual Aids and the Medical Library," will be held May 28. W. B. McDaniel, librarian of the College of Physicians of Philadelphia, will give the presidential address at the morning meeting, May 29.

The Association of Southeastern Biologists will hold its 8th annual meeting at Emory University, Georgia, April 18–19, with the southeastern section of the Botanical Society of America and the Southern Appalachian Botanical Club. All biologists in the Southeast are invited to attend.

The Fifth International Pediatrics Congress will be held July 14–17 at the Waldorf-Astoria Hotel, New York City.

The Congress, with L. Emmett Holt, Jr., Bellevue Hospital, New York, as general secretary, will consist of scientific discussions, a scientific exhibit, visits to medical institutions in New York, and a post-Congress tour. The scientific discussions will consist of 8 plenary sessions on nutrition, tuberculosis, alimentary toxicosis, virus diseases, chemotherapy, congenital heart disease, neonatal mortality, incompatibility of blood, as well as other subjects.

The scientific exhibit on display throughout the Congress will consist of 250–300 booths showing advances in pediatrics and the field of medicine as a whole.

Following the Congress, three days will be spent in visits to hospitals in New York City. Delegates will then be taken on a post-Congress tour to other cities along the Atlantic Seaboard and perhaps in the Middle West. In each city a scientific program will be presented, including visits to pharmaceutical and food industrial plants.

Elections

The American Association of Petroleum Geologists has elected as president Carroll E. Dobbin, regional geologist, U. S. Geological Survey, Denver, Colorado. Dr. Dobbin took office at the close of the 32nd annual meeting of the Association in Los Angeles, March 24–27.

The Potomac Division of the American Phytopathological Society, at its 4th annual meeting on February 20, elected V. F. Tapke, president; W. F. Jeffers, vice-president; W. W. Diehl, secretary-treasurer; and E. E. Clayton, councilor.

The Southern Society for Clinical Research, established to encourage research in the medical sciences, elected the following officers at its first annual meeting in New Orleans, January 25: Tinsley R. Harrison, Dallas, Texas, president; William J. Darby, Jr., Nashville, Tennessee, vice-president; and Thomas Findley, New Orleans, Louisiana, secretary-treasurer. The following are councilors: Paul B. Beeson, Atlanta, Georgia; Robert M. Moore, Galveston, Texas; Joseph W. Beard, Durham, North Carolina; and Harold B. Greene, Winston-Salem, North Carolina. The founders' group consists of 40 men from various medical schools in the South, but membership is not limited to academic institutions.

The Geological Society of Washington elected the following officers for 1947: W. P. Woodring, U. S. Geological Survey, president; Ernst Cloos, Johns Hopkins University, and C. H. Dane, U. S. Geological Survey, vice-presidents; M. K. Carron, of the Survey, treasurer; M. H. Krieger and G. T. Faust, also of the Survey, secretaries.

Recent Deaths

V. M. Goldschmidt, 59, director, Geological Museum, University of Oslo, Norway, died March 20. After several periods of imprisonment during the occupation of Norway, Dr. Goldschmidt escaped early in 1943 to Sweden and then to Scotland and England. He worked in the MacCauley Institute for Soil Research, Scotland, and Rothamstead Experimental Station in England during the remainder of the war.

Samuel Morris, a member of the chemistry staff of West Virginia University since 1916, died March 20 in Morgantown, West Virginia.

The American Board of Pathology has changed the dates of examinations to be given in 1947 to June 5–6 in Philadelphia and October 24–25 in Chicago. Applications for the Philadelphia examination will be received until May 1 and for that in Chicago until September 15. Inquiries should be sent to Robert A. Moore, American Board of Pathology, Washington University School of Medicine, St. Louis 10, Missouri.

The National Registry of Rare Chemicals, Armour Research Foundation, 35 West 33rd Street, Chicago, lists the following wanted chemicals: Trihexylamine; trihydroxyglutaric acid; mercuric metatellurate; cupric metaborate; 1-methylanthracene; cobaltic sulfate; gallium metal and salts; lead tetraoxysulfate; laccase; polyphenol oxidase; thioveronal; 1-glyceraldehyde; 1-glyceric acid; erythritol and anhydride; dl-cysteine hydrochloride; tantalum pentachloride; columbium pentachloride; emetine; diphenylhydroxylamine; and methylisopropylcyclopentanes.

A New York State Science Council will be provided under terms of a bill introduced in the state legislature by Thomas C. Desmond, state senator of Newburgh, New York, who said that "scientific changes, from splitting of the atom to supersonic airplane flight, demand that New York State plan wisely in a new Age of Science."

"Under the bill," he said, "the Governor, with the consent of the Senate, will appoint 20 members. Three need not be technical experts. The other 17 must be persons of 'outstanding qualifications and attainment,' one each from the following fields of scientific research: physics, chemistry, biology, botany, psychiatry, electrical engineering, sociology, agronomy, geology, zoology, anthropology, aeronautical engineering, bacteriology, surgery, medicine, civil engineering, and mechanical engineering.

"The Science Council will be empowered to: (1) make a continuous survey and study of modern developments in various phases of science and advise the Governor and legislature of such developments and their probable effect on the state generally and on social, commercial, and industrial institutions, health, power developments and other matters of state concern; (2) collect, analyze, and compile annually a list of scientific research projects contemplated by various state departments and agencies and advise such departments and agencies regarding the coordination, development, or restriction of such projects. This would result in a research priority list; and (3) develop a long range scientific research program for the state and encourage scientific research under public and private auspices.

"Members of the Council, who will receive no compensation except expenses, need not be residents of the state.

"Scientists, until recently, have been reluctant to get embroiled in the hurly-burly of shaping government decisions. Scientists must be encouraged to come out of the laboratories and to assume some responsibility for guiding public policies.

"Creation of this Science Council," Senator Desmond continued, "will give our state the benefit of the advice and judgment of some of the foremost scientists in the country. It will probably save our state from making unwise outlays of money for projects which may be outmoded a few years after construction by scientific developments."

U. S. Civil Service Boards of Expert Examiners

Probably very few activities have forced as serious reconversion tasks following the war as has the U. S. Civil Service Commission. The great upsurge of Federal employment occasioned by war necessities made necessary new techniques in recruiting, examining, hiring, and classification of employees. Most of these were temporary emergency measures. In the field of scientific personnel the break with the past was even more dramatic because of the unprecedented employment necessitated by the technical jobs to be done. The secrecy attending this type of work still further complicated the employment pattern.

The reconversion to a peacetime civil service pattern has, therefore, been more than usually difficult in the field of scientific personnel. An earlier issue of *Science* (April 12, 1946) has reported the establishment of the Advisory Committee on Scientific Personnel by the Civil Service Commission. This Committee has studied many problems relating to the status of scientists in Federal employment and has made a number of recommendations to the Civil Service Commission. As one of its recommendations, the Committee suggested the widespread extension of the plan of boards of expert examiners, used in some cases earlier by the Civil Service Commission. This program has been accordingly widely extended, particularly for scientific personnel. The Commission has set up regulations governing this new departure, and already a number of such committees are functioning.

Sixty-five such committees have been established in 18 departments and agencies, 6 of these being major departments and 12 being agencies. Of the 51 agencies in the departmental service, 29 are expected ultimately to set up committees. The pattern is flexible, some agencies having central policy groups and subcommittees in the different branches. Others again have subcommittees as operating parts of a central operating committee. Other agencies have decentralized the work entirely into the hands of bureau or branch committees. Of the departments and agencies not yet having committees, several are expected to announce formations of committees shortly.

Already 22 examination announcements covering 168 examinations have been published by these committees. Examinations have already been held in 20 cases, and 6 registers of qualified candidates for Federal employment in the respective fields have been established. Eighteen other examination announcements are being currently prepared. These examinations cover subprofessional levels 4 to 8 ($2,168-$3,397), clerical, administrative, and fiscal series 5 through 15 ($2,644-$9,975), and professional series 1 to 8 ($2,644-$9,975).

These boards of expert examiners collaborate with the Civil Service Commission representatives in drafting recruiting standards, preparing examination announcements, constructing the examinations, developing schedules for rating experience and training, obtaining supplemental evidence from applicants as to their qualifications, rating examinations, etc. The members must be of outstanding competence in the scientific, professional, or technical fields in which the examinations are held.

The importance of the new system may be judged by the fact that it places responsibility for setting up examinations and all other steps involved in the selection of qualified candidates in the hands of operating scientists of mature experience with governmental laboratories and the particular branch of science. These men, together with representatives of the Civil Service Commission, who are expert in the legal phases of government employment and Commission regulations, supervise and carry out all of the necessary processes. They can initiate and carry out certain types of recruitment activities; and they can assist in disseminating factual information on government employment of scientific personnel.

The success of the plan will be largely dependent on the stature of the membership on committees. It is gratifying to note that the average grade level and professional standing of this membership indicates a high degree of interest and devotion to the program. Taking half of the committees, including about 100 committee members, as an adequate sample, 96 are permanent civil service employees, the average length of service being 16 years; 33 have Doctor's degrees; 17 have Master's degrees; and 38 have the A.B. degree. In point of administrative responsibility, 11 are either heads or assistant heads of bureaus or agencies; 31 are division chiefs; 17 are assistant division chiefs; and 3 are section chiefs. The remaining 38 are professional employees. Almost half are of the grade P-7 or above. Two rank P-3; 12, P-4; 18, P-5; and 18, P-6. On the basis of these statistics it is clear that the committees are commanding the attention of many of the ablest and most experienced scientific employees.

Although it is too early to hazard an appraisal of the work of these committees or boards, it seems fair to expect that they will contribute greatly to the careful selection of scientists on the Federal payroll and hence contribute substantially to the ultimate soundness of government scientific work. They should also furnish an informal liaison, through the educational and scientific lay contacts of the members, to the scientific public for the interchange of authoritative information on personnel and on government employment in this field of work. This seems important in an age when the Federal role in science is clearly increasing in importance and must necessarily still further increase. (M. H. TRYTTEN, *Director, Office of Scientific Personnel, National Research Council.*)

Make Plans for—

The Electrochemical Society, Inc., annual congress, April 9–12, Louisville, Kentucky.

American Chemical Society, spring meeting, April 14–18, Atlantic City, New Jersey.

Institute of Mathematical Statistics, meeting on stochastic processes and noise, April 24–25, New York City.

National Academy of Sciences, annual meeting, April 28–30, Academy Building, Washington, D. C.

American Medical Association, centennial session, June 9–13, Atlantic City, New Jersey.

COMMENTS *by Readers*

The announcement of the 6th International Congress of Experimental Cytology states: "The Congress will be open to scientists of all nationalities except German and Japanese."

To exclude from an international scientific congress any group of colleagues on the basis of nationality is to make a travesty of both appellations—international and scientific. Surely, science transcends considerations of nationality, as of race, color, and creed. For scientists to discriminate against colleagues on the basis of nationality is to commit the very crime against civilization which justified to many their participation in the war.

From the practical aspect no less than from the standpoint of scientific ethics is such a policy of exclusion disastrous. In science each builds on the other's work; exclusion is as harmful to those who practice it as to those excluded.

Sweden, host to the Congress, enjoys a deserved reputation for fairness and justice. I am convinced that the Swedish organization committee would welcome an expression of opinion on this policy. Other International Congresses are in preparation. If truly international, their influence can be great in restoring intellectual communication and mutual understanding. To that end, protests against exclusion of colleagues on such nonscientific grounds as nationality should reach the organization committees as soon as possible. (Sally Hughes-Schrader, *Department of Zoology, Columbia University.*)

Interesting calculations of the unequal distribution of diffusible nonelectrolytes across a membrane have been made by C. L. Deasy (*Science*, October 25, p. 388); the inequality is a consequence of the presence of a nondiffusible nonelectrolyte on one side of the membrane. Without questioning these calculations, one is inclined to be skeptical of the suggested importance of this phenomenon in the case of biological membranes.

No mention is made in Deasy's paper of the difference in pressure required to maintain equilibrium in an osmotic system of this sort. From the derivation given by F. T. Wall (*J. Amer. chem. Soc.*, 1944, **66**, 446) it is clear that Deasy's equation is based on the assumption that this pressure difference exists, and that it is calculable from the mole fractions of solvent by the usual logarithmic equation. If the mole fraction of nondiffusible solute is 0.05, the distribution ratio for dissolved CO_2, according to Deasy, is 0.89. It may be calculated, however, that the pressure difference at equilibrium must be, at 38° C., more than 70 atmospheres. The magnitude of this pressure indicates that the assumed conditions are hardly physiological. For a pressure difference of 25 mm. Hg, which is low enough to be physiologically possible, the distribution ratio becomes 0.99995. In the absence of very great differences in pressure, the calculated distribution will not be sufficiently unequal to require consideration in the explanation of physiological phenomena. (David I. Hitchcock, *Laboratory of Physiology, Yale University School of Medicine.*)

May I add a footnote to Henry K. Beecher's interesting article on "Anesthesia's Second Power," appearing in *Science* for February 14, in the form of a quotation from Oliver Wendell Holmes that may help to throw the aforesaid "second power" into perspective?

"I once inhaled a pretty full dose of ether, with the determination to put on record, at the earliest moment of regaining consciousness, the thought I should find uppermost in my mind. The mighty music of the triumphal march into nothingness reverberated through my brain, and filled me with a sense of infinite possibilities, which made me an archangel for the moment. The veil of eternity was lifted. The one great truth which underlies all human experience and is the key to all the mysteries that philosophy has sought in vain to solve, flashed upon me in a sudden revelation. Henceforth all was clear: a few words had lifted my intelligence to the level of the knowledge of the cherubim. As my natural condition returned, I remembered my resolution; and, staggering to my desk, I wrote, in ill-shaped, straggling characters, the all embracing truth still glimmering in my consciousness. The words were these (children may smile; the wise will ponder): '*A strong smell of turpentine prevails throughout*'" (from *Mechanism in thought and morals.* Boston: Houghton Mifflin Company. Cf. also H. M. Johnson, "The real meaning of fatigue," *J. nat. Inst. industr. Psychol.*, 1929, **4**, 433–45). (John F. Dashiell, *Department of Psychology, University of North Carolina, Chapel Hill.*)

The article by Haley and Flesher (*Science*, December 13, p. 567) suggests the following comment:

Besredka formulated the rule that if the same substance is injected into the same subject, in the same amount and in the same way, at intervals of 10 days, the resulting reactions will be approximately equal in intensity. If the interval is shorter, the intensity will be successively less and less; if the interval is longer than 10 days, the reactions will be successively more and more severe.

The authors state that the injection of a sensitizing dose increases the resistance of the animal to toxic injections of thiamine chloride. This is actually so in their experiment and due to the desensitizing interval of 7 days. Had the interval been more than 10 days, the effect of the sensitizing dose would have been the other way. An extensive experience with the rule makes me put considerable faith in it.

The case of death following injection of thiamine hydrochloride was reported by Webb and Reingold and quoted by the authors. The fatal injection was given after an interval longer than 10 days, and the previous injection had also been given after an interval of more than 10 days. This made the sensitization progressive. In both this case and the experiment of the authors, the responses occurred according to the rule.

It would be very interesting if the experiment were repeated with an interval of 14 or 21 days and the result reported. The rule is very important and not commonly observed. (Joseph F. Bicak, *Mosholu Parkway South, New York City.*)

TECHNICAL PAPERS

Cinephotomicroscopy of Normal Blood Circulation in the Cheek Pouch of the Hamster[1]

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Precise microscopic studies of the peripheral circulation in the living animal require the use of thin, nonpigmented tissues which can be illuminated by transmitted light to reveal the structure of the walls of the smallest blood vessels. The number of suitable preparations is small, particularly in the mammal. Direct microscopic investigations in mammals have been made largely on the newly-formed blood vessels in transparent chambers inserted in the ear of the rabbit (*2*) and on the blood vessels in the mesentery of the gut (*1*). More recently, microscopic observations on the circulation in the wing of the bat have been reported (*4*). The investigators in this laboratory have used a new preparation for cinephotomicroscopic studies on small blood vessels, namely, the cheek pouch of the golden hamster (*Cricetus auratus*).

The hamster cheek pouch is a paired structure located inside the mouth cavity and used for temporary storage of food. *In situ* the wall of the pouch possesses numerous longitudinal folds which make it adaptable to considerable distention. The normal pouch is approximately 1½ inches in length and extends posteriorly to a position near the shoulder.

Its histological structure has been examined in sections stained with hematoxylin and eosin. The pouch is lined with stratified squamous epithelium consisting of from two to five layers of cells which become progressively flatter toward the surface, on which a slight amount of cornification is present. A relatively dense layer of fibrous connective tissue is found beneath the epithelium. Longitudinally arranged skeletal muscle fibers are numerous at the edge of this layer near the open end of the pouch but absent at the blind end. A layer of loose areolar connective tissue joins the wall of the pouch to the subcutaneous tissue of the cheek. Blood vessels are numerous in both connective tissue layers and skeletal muscle.

When the pouch is everted by gentle traction with forceps, the loose connective tissue between the subcutaneous tissue of the cheek and that of the pouch wall separates. The thin, nonmuscular portion of the pouch nearest the blind end is selected for use.

The animal is anesthetized with 6.5 per cent pentobarbital sodium (initial dose, .15 cc./animal, with fortification by .05 cc. increments at hourly intervals) and placed in a specially adapted Petri dish (6 inches in diameter). The dish is equipped with a glass platform cemented to the bottom. The pouch is everted and the portion near the tip extended over the glass platform and pinned on paraffin, producing two flat layers. A crescent-shaped cut is made in the upper layer, forming a flap of pouch wall with the limbs of the crescent directed toward the free end of pouch. The flap is pulled back, exposing a portion of the inner or connective tissue aspect of the lower layer of the wall. A considerable amount of the loose connective tissue is removed by careful dissection under the binocular microscope. The pouch may be turned over and the inverted single-layered flap repinned with the epithelial aspect uppermost. The dish is fastened to the mechanical stage of a microscope equipped with a light-splitting prism for simultaneous viewing and motion-picture recording.

The effect of a substance in solution on a small blood vessel is studied by application with a micropipette to either the epithelial surface or the connective tissue side of the pouch.

Spontaneous intermittency of flow is very frequent in the small blood vessels of the hamster's cheek pouch. This is of two kinds: (1) that produced by the action of sphincters at the arterial end of capillaries; and (2) that produced by changes in the blood-pressure differential between the two ends of the capillary.

Intermittency of flow resulting from the action of smooth-muscle sphincters at capillary origins has been observed in the frog's retrolingual membrane (*3*). Similar sphincteric activity occurs in the small blood vessels of the hamster cheek pouch. A decrease in diameter of the capillary wall and deformation of red cells were observed at the point of branching of a capillary from the supplying precapillary arteriole, which did not change in caliber. This observation has been recorded in a motion-picture sequence taken at a magnification of 1,200 times. In the frog the arterioles, as well as capillary sphincters, may contract completely, stopping the flow of blood. In the hamster the arterioles rarely contract completely, and only small areas of tissue are deprived temporarily of a blood supply by the action of sphincters at capillary origins.

Intermittency of flow has been observed in capillaries when sphincteric action was not occurring in these vessels. In favorable preparations demonstrating this type of intermittency, the wall of the capillary remained completely open throughout the entire length. The flow stopped periodically in the capillary but continued without observable change in either the arteriole or the venule. Actual reversals in direction of flow in capillaries have been observed frequently. Intermittency of this type may be explained on the basis of changes in the blood-pressure differential between the two ends of the capillary involved.

Both types of intermittency, that involving sphincteric activity of the capillary origin and that without, have been observed in adjacent small blood vessels in the same vascular area. It is possible that pressure changes producing the intermittency may be caused by small changes in caliber of the arterioles or by sphincteric activity in an anastomosing portion of the vascular bed.

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[1] This research work was supported by Bristol-Myers Company, New York.

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Vascular Changes in the Wings of Bats

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In a series of articles published since 1939 it has been proposed that acquisition of progressively higher operating temperatures may have been one of the fundamental factors in the evolutionary processes of terrestrial animals (*2*, *4*, *5*). It has also been suggested that transgression of the threshold of either somatically or germinally tolerable temperatures, particularly the latter, constitutes one of the major hazards to survival (*3*, *4*, *5*, *7*) and even may be the key to extinction in some the the major groups of terrestrial animals (*2*; for contrasting views, see *1*). In these papers it has also been stated by the present writer that the existence of heat sensitivity in male germinal processes, in combination with the thermal progression seeming to characterize major groups of terrestrial animals, may have expedited the process of evolution on land.

Thinking along this line inevitably points to the importance of investigating all instances in which there is an appearance of testicular thermal tolerance equal to that of the somatic cells.

Among terrestrial animals, the exceptionally high normal body temperatures of the birds, especially when considered in conjunction with the internal location of their testes, would seem to indicate that they would fit this category since their spermatogenic activity must take place at abnormally high temperatures. However, until additional observations have been made, this will remain only a partially acceptable assumption. The universality of heat susceptibility in other groups and Riley's findings on interrupted spermatogenesis (*9*) suggest the possibility that temperature may influence spermatogenesis in the English sparrow, and this view is strengthened through the finding by Cowles and Nordstrom (*8*) of an avian analogue to the mammalian phenomenon of testicular descent and possible scrotal thermoregulation. In this avian phenomenon it was demonstrated that the testes of Brewer's blackbird migrate a short distance, so that, while they are spermatogenetically active, they lie between two folds of the abdominal air sac.

Following the same lines of thought that led to investigations on the air sac-testes relationship in birds, it became apparent that a somewhat similar situation might be encountered in some Nearctic bats.

Several species of temperate-zone bats are known to breed in late summer or early fall, and throughout the summer months many of them are daytime occupants of hot attics; yet, despite this exposure to theoretically unfavorable temperatures, they are among the minority of nonscrotal vertebrate animals which reach the peak of spermatogenic activity toward the end, rather than before, the season of maximum summer temperatures. This situation is in marked contrast to conditions found in other terrestrial organisms, since the great majority of birds, most nonscrotal mammals, reptiles, and amphibians give at least the appearance of requiring a prolonged period of cool or cold winter weather prior to resumption of spermatogenesis. This condition (winter rest?) strongly suggests that there is need of moderate thermal conditions for testicular rehabilitation from heat effects. It seems possible that our long, hot summers may explain the widespread regression of the testes characterizing so many temperate-zone animals, a condition that frequently sets in not long after the onset of hot summer weather. Certainly there is a strong resemblance between this situation and that produced in *Xantusia vigilis* by artificial heat sterilization (7), and a similar condition is illustrated by the 13-lined ground squirrel (*10*).

Because of the effectiveness of their thermoregulatory device, scrotal mammals seem not to be so rigorously limited to early spring or summer breeding. Although exceptions to this general rule of postwinter breeding are known, they are not numerous. However, because of the known effects of light on gonadal activities it will be necessary to test the respective missions of these two factors.

Although Nearctic bats are *hemipoikilothermic organisms, they are characterized by testicular descent and testes migration into the tail membrane, the uropatagium*, where cooler conditions should prevail. In spite of this presumable protection, it is possible that this effect might be canceled by two heating factors: (1) the nature of their daytime retreats, which might prevent the normal daytime fall in temperature; and (2) their heat-generating nocturnal activities, chiefly the pursuit of food, which is to a large extent captured while in flight. The importance of this latter factor is accentuated by the bat's notable capacity for heat generation, a requisite for these animals to enable them to preheat their bodies in preparation for flight. Taken together, these two conditions suggest that the bats may either furnish an example of an animal that has succeeded in achieving identical somatic and spermatogenic heat tolerance or that they have some unusually effective means for heat dissipation and thermal regulation.

For a preliminary excursion into the thermal relationships of these animals it was clear that the effectiveness of the flight membranes should be evaluated as heat-dissipating and thermoregulatory structures. These comparatively large areas are usually devoid of hair and are highly vascularized and thus suitable for heat exchange mechanisms. A preliminary rough survey of ratios between the surface areas of the furred body and the naked flight membranes shows that these proportions range from 4:1 to as much as 8:1 in Nearctic bats but 12:1 in the tropical fruit bats.

In the common and rather typical bat, *Myotis yumanensis sociabilis*,[1] a superficial observation on the degree of vascular change in the network of blood vessels in the flight membranes clearly revealed marked changes in the amount of blood passing through these tissues. These changes were readily correlated with body temperatures.

In experiments conducted up to the present time it has been found that engorgement of the vascular plexus in the membranes is induced by elevating the body temperature to between 40 and 41° C., but that between 10 and 38° C. there are no gross, readily perceptible alterations in the amount of blood flow. Throughout this range the wing and tail membranes retain the comparative pallor characteristic of low-temperature conditions. When the change does occur, it is so sudden and so notable that students readily perceive the difference even at a distance of several feet. Exact measurements of temperature differences between the arterial and venous flow are expected to reveal even more interesting information.

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[1] For the identity of this bat and for information on the position of the testes in the uropatagium I am indebted to Mr. Kenneth Stager, of the Los Angeles Museum.

That bats might possess somatic and spermatogenic thermal homogeneity seemed as reasonable as to have supposed that the birds might do so; however, the morphological arrangements in both of these animals seem to point to a provision for heat protection, and it is now reasonable to proceed to the acquisition of more exact physiological data, with the expectation that lower testicular temperatures can be demonstrated during the period of spermatogenesis.

If neither of these animals can be shown to possess somatic and spermatogenic thermal equality, the condition should still be sought in other organisms. However, if it is demonstrated that this thermal difference is universal, as our present limited information suggests it may be, it seems probable that some profound and fundamental difference will be found in the basic physical or chemical attributes of these two classes of cells.

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Carbon and Hydrogen in Rubber Hydrocarbon

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Analyses, by combustion, of rubber hydrocarbon separated from rubber latex and crystallized from ethereal solutions at low temperatures yielded combined percentages of carbon and hydrogen which totaled slightly less than 100 (*4*). Midgley (*1*) assumed the difference to be due to oxygen, and he and his co-workers have used the results to substantiate their argument that natural rubber is not a true hydrocarbon but contains a small amount of oxygen in chemical combination.

Later, Roberts (*2*) reported that he had isolated the portion of rubber which contained oxygen. This he called caoutchol, to distinguish it from the hydrocarbon, which he named caoutchene. He used Midgley's results to confirm his findings, which he attempted to apply in a new way to the familiar two-phase theory of Fessenden as an explanation of the properties of rubber. However, Schidrowitz (*3*) has indicated that the method used by Roberts to separate the caoutchol is not free from possible criticism. Some steps in the procedure, e.g. milling, promote oxidation.

Since publication of the analyses made at the Bureau of Standards the values for the atomic weights of carbon and hydrogen have been changed from 12.00 and 1.0078 to 12.010 and 1.0080, respectively. When these earlier results are recalculated with the new atomic weights, the sums of carbon and hydrogen are increased by 0.061 per cent. When the results reported in the earlier paper are corrected for two typographical errors and this increment is added, the recalculations are as shown in Table 1.

TABLE 1

Composition of Rubber (Recalculated)

	Hydrogen	Carbon	Sum	Ratio Hydrogen: Carbon
Rubber hydrocarbon uncrystallized	11.85	88.03	99.88	0.1346
	11.84	88.11	99.95	.1343
	11.77	87.66	99.43	.1342
	11.85	88.03	99.88	.1346
	11.82	87.92	99.74	.1344
Average			99.78	
Crystallized once	11.86	88.06	99.92	.1346
	11.82	88.02	99.84	.1343
Average			99.89	
Crystallized three times	11.87	88.31	100.18	.1344
	11.86	88.13	99.99	.1345
Average			100.05	
General average			99.87	

Several things should be said about these results if they are to be used as a basis for judging whether oxygen constitutes a part of the normal rubber molecule: (1) The sum of carbon and hydrogen found increased with increasing purification of the rubber. (2) The most carefully purified material gave an average sum of carbon and hydrogen in excess of 100 per cent, and the four analyses of hydrocarbon which had been recrystallized at least once averaged 99.97. (3) The differences between analyses of the same material were greater than the average difference between the sum of hydrogen and carbon and 100 per cent. The latter cannot, therefore, be regarded as certainly significant. (4) The absolute purification of the rubber hydrocarbon cannot be assumed. Substantially all probable impurities, including water, ether, dissolved or adsorbed gases, inorganic material, and products of oxidation of the rubber itself, would have lowered the sums of hydrogen and carbon observed.

Certainly the results leave very little, if any, of the weight of the rubber to be accounted for as normally combined oxygen. This is not all, however. The observed ratio of hydrogen to carbon is higher than the theoretical (0.1343) by an amount that appears less significant than it really is, in comparison with the total weight of carbon and hydrogen, because of the small weight of hydrogen. For the entire series of analyses the weight of carbon dioxide found was 0.21 per cent lower than that computed from the weight of rubber burned, the weight of the water being only 0.06 per cent low. For the four samples of recrystallized rubber, the carbon dioxide was 0.09 per cent low and the water 0.08 per cent high. These differences are in the direction we would expect if the discrepancy in the total weight were the result of probable impurities in the rubber, particularly water and ether; on the other hand, the presence of oxygen combined as hydroxyl would not affect the ratio of hydrogen to carbon, and in the form of other probable radicals it would reduce that ratio.

If the small difference between the theoretical value and the sum of hydrogen and carbon is to be considered significant, the difference between their theoretical and observed ratios must also be significant, and this definitely indicates incomplete purification rather than combined oxygen, as postulated by Midgley.

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Variation Among Lamb Carcasses in the B Vitamin Content of Meat[1]

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It is generally accepted that ruminants do not require the B vitamins. Hence, the variation in ration content may be assumed to have no effect on the B vitamin content of their meat.

Nevertheless, considerable difference in B vitamin content of the raw meat of different carcasses of beef has been reported (*1*). This difference has been questioned on the grounds that there was no way to remove the variation associated with carcasses from that associated with performing the analyses at different times. In more recent experiments with groups of lamb carcasses, however, there have been findings similar to those in the previous study. The additional evidence, moreover, was obtained from an experimental design improved to meet the previously mentioned criticism.

The experiment was originally planned to overcome as nearly as possible the suspected variation between carcasses. But the variation was notable even under these conditions. Because the details of the entire experiment of which this study is a part will be given in subsequent papers, only those details concerned with carcass differences will be given here.

The samples of meat were obtained as follows: Cubes of meat from a wholesale cut (triangle) were mixed for each of four carcasses separately. Enough cubes to weigh exactly 125 grams were taken from each of the four carcasses and combined to make one 500-gram sample. Equal numbers of 500-gram packages were placed in each of two flat pans and frozen in the deep freezer, where they were kept until needed. To obtain replications, this entire procedure was repeated with meat from other lots. Six replications were employed, making a total of 24 lamb carcasses. Storage periods between killing and freezing were held constant, as were those between freezing and analysis, so that these storage periods would not be a possible cause of variation in vitamin content. The same sample was used for the determination of the following B vitamins: thiamine, pantothenic acid, niacin, and riboflavin.

In preparation for testing, one of the two pans in a replicate was removed to the laboratory, where the samples were allowed to thaw in the refrigerator. Two of the samples were analyzed raw, the other samples after cooking. One week later the other pan of samples from the same replicate was removed and the raw samples treated in like manner. Thus, two combinations of the data on raw meat were possible: those associated with order of analysis and those associated with replications. Since the data were collected in this fashion, the variation associated with doing the analyses at different times could be removed from replications by an analysis of variance.

TABLE 1

Variation in Vitamin Content Between Replicates (Groups of Carcasses)

Replicate No.	No. of samples	Thiamine	Pantothenic acid	Niacin	Riboflavin
		Actual content (µg./gram dry free-fat basis)			
1	4	8.22	24.75	262.9	12.91
2	4	9.33	25.49	257.4	11.58
3	4	11.72	25.16	231.9	11.37
4	4	7.01	28.65	269.8	10.57
5	4	8.34	24.30	287.2	10.40
6	4	8.15	26.73	270.5	11.57
Greatest difference (highest—lowest)		4.71	4.35	55.3	2.51
Percentage difference*		67	18	24	24
F value of replicates†		28.29‡	13.80‡	25.13‡	37.78‡

* Calculation $= \dfrac{\text{greatest difference} \times 100}{\text{lowest replicate}}$.

† Calculated from dry fat-free basis.

‡ Error terms were remainder after replicates, order, and O × R were removed.

F values needed for significance were: 0.05 level = 3.11, 0.01 level = 5.06.

The average vitamin content of each of the 6 replicates is given in Table 1. The variation is shown by the differences between the highest and lowest value, the percentage difference, and the F value. As will be seen, the difference between replicates is highly significant for all of the four vitamins in lamb. The percentage difference in each case is above any recognized value for experimental error. It would appear that the highly significant difference between replicates is associated with something other than the different occasions on which the analyses were made. Carcasses (or groups of carcasses) are apparently the dominant factor associated with replicates. It seems probable that the difference would have been even greater had the analyses been made on individual rather than on groups of carcasses.

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[1] The work on which this paper was based was supported in part by a grant from the National Live Stock and Meat Board.

That the meat of lamb varies in B vitamin content from carcass to carcass is of unusual interest because lambs are known not to require the B vitamins. Sheep have been shown to synthesize thiamine, pantothenic acid, and riboflavin in the rumen (*2*), and an excretion study indicates that they also synthesize niacin (*3*).

There are no clues as to why some of the animals had higher B content in the meat than others, because production histories could not be obtained during the emergency period when this meat was purchased. Whether the factors which control the B vitamin deposition in the meat are environmental or genetic must be determined by further research.

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The Effects of Cytochrome C in Anoxia

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Proger and his co-workers (*4*) have reported that intravenously administered cytochrome C is capable of mitigating the physiological effects of anoxia. In view of these reports it was thought that cytochrome C might be of value in preventing cyanide intoxication. Experiments to be reported elsewhere failed to demonstrate any significant effect of cytochrome C in cyanide-poisoned rats. Further work was then carried out in an attempt to confirm two findings of Proger and his group which were susceptible to objective and quantitative measurement: the effects of cytochrome C on the organ content of easily hydrolyzable phosphorus compounds, and the survival times of anoxic rats.

The resynthesis of adenosine tri- and diphosphate from adenylic acid and inorganic phosphate is coupled to oxidative processes (*3*) and should be diminished under conditions of anoxia. The tissue content of adenosine tri- and diphosphate parallels the content of easily hydrolyzable phosphorus (*2, 3*). In addition, under conditions of anoxia the blood level of lactic acid increases (*1*). In our experiments the amount of easily hydrolyzable phosphorus in heart and kidney, the blood level of lactic acid, and the measurement of survival times were used to quantitate the effect of anoxia on rats and to measure the value, if any, which cytochrome had in the treatment of anoxia.

In the first experiment both members of pairs of littermate white rats were given 2.0 cc./kg. of physiological saline intravenously. One member was then placed in an atmosphere of 3.9 per cent oxygen, and the other allowed to breath air. After 8 minutes determinations of the easily hydrolyzable phosphorus ("7-minute phosphorus") of kidney and heart and of the blood lactic acid were made. These revealed a significant difference in all three quantities between those rats which breathed 3.9 per cent oxygen and those which breathed air (Experiment 1, Table 1).

In the second experiment both members of pairs of littermate white rats were placed in an atmosphere of 3.9 per cent oxygen after one had been given approximately 20 mg./kg. of cytochrome C in saline intravenously and the other an equal volume of physiological saline. Determinations of the same three quantities as in Experiment 1 revealed no significant difference between the cytochrome C and saline pretreated animals (Experiment 2, Table 1).

TABLE 1

Effect of Cytochrome C on Several Manifestations of Anoxia in Rats

Experiment	No. of pairs	Treatment of animals	Mean of differences between test and control*	P*
1	7	Pairs of rats (test and control) pretreated with saline. Test placed in an atmosphere of 3.9 per cent oxygen for 8 minutes; control remained in air.		
		Kidney 7-minute phosphorus (mg./100 grams fresh tissue)	−2.37	0.025
		Heart 7-minute phosphorus (mg./100 grams fresh tissue)	−5.07	0.025
		Blood lactic acid (mg./100 cc. blood)	110.8	Less than 0.01
2	11	Pairs of rats (test and control) placed in 3.9 per cent oxygen for 8 minutes. Test pretreated with cytochrome C; control pretreated with saline.		
		Kidney 7-minute phosphorus (mg./100 grams fresh tissue)	0.27	0.68
		Heart 7-minute phosphorus (mg./100 grams fresh tissue)	−0.78	0.41
		Blood lactic acid (mg./100 cc. blood)	−0.64	More than 0.90
3	25	Pairs of rats (test and control) placed in 2.8 per cent oxygen. Test pretreated with cytochrome C; control pretreated with saline.		
		Survival time (min.)	0.66	0.45

* The differences between the test and control animals with respect to the measured quantities were found, and from these the values of P, representing the probabilities that the observed differences were due to chance, were determined.

In the third experiment both members of pairs of white rats of the same age, weight, and sex were placed in an atmosphere of 2.8 per cent oxygen after one had been given 5 mg. of cytochrome C in saline and the other an equal volume of physiological saline intravenously. There was no significant difference in the survival times of the members of each pair (Experiment 3, Table 1).

These results do not confirm the findings of Proger and his collaborators in similar experiments.

The experiments will be reported in detail elsewhere.

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Effects of Ultraviolet Radiation on Visual Thresholds

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In a recent paper (*1*) E. Ludvigh and V. E. Kinsey demonstrated that visual-threshold light-difference sensitivity and critical flicker frequency tests in the *fovea* are not affected by previous exposure for 5 minutes to the radiation of a 1,000-watt mercury vapor arc, from which most of the visible and almost all of the ultraviolet radiation shorter than 320 $m\mu$ were filtered out. These findings seem to contradict the results obtained with baby chicks (*2*, *3*), in which extensive changes in sensitivity thresholds were obtained and which the authors cited can attribute only to the marked difference in absorption and in general physiological characteristics between the eyes of baby chicks and those of adult human beings. They conclude that ultraviolet radiations longer than 320 $m\mu$ encountered in nature are without deleterious effect on these functions of the normal human eye.

For the chick (*2*, *3*) as well as for the human eye (*4*) it has been shown that pre-exposure to the radiation of a mercury vapor arc emitting ultraviolet light above 285 $m\mu$ in addition to the visible wave range raises the final dark-adapted thresholds considerably above the normal level (1.3 log unit for the chick and 0.25 log unit for the human eye), as compared with pre-exposures to the same source but with all ultraviolet filtered out. The adapting brightness is in both cases the same, and hence it is assumed that the final threshold differences are due to the ultraviolet. In Fig. 1 data are given for one human observer (light exposure, 10 minutes, with a large adapting field; test with a 12.5° square field; central fixation; presentation, 1/25 second) and for a series of baby chicks (pre-exposure, also 10 minutes). The data for the human eye are individual readings; the chicken data are averages. The figure shows the interesting fact that in both cases the cone part of the duplex dark-adaptation curves is unaffected by the pre-exposure to ultraviolet, while the rod segments are clearly altered. For the human curve the onset of rod adaptation is delayed for about two minutes, the cone segment overshooting the normal beginning of rod adaptation and remaining above the previously established level until termination of the test. For the chick the slopes of cone and rod segments are quite different from those for the human, so that, due to the steepness of the cone segment, an overshooting is not apparent. It is also found that a reduction of the extent of the ultraviolet spectrum reduces the effect on final thresholds; light containing only wave lengths above 365 $m\mu$ has no effect. Ultraviolet alone, after largely eliminating visible light, acts in qualitatively the same manner as visible light to which ultraviolet has been added.

Previously it has been pointed out (*3*, *4*) that the effect of ultraviolet upon the cones is probably prevented by their dense pigmentation, while it acts upon the pigment-free rods. Therefore, while testing *foveal* intensity discrimination, or flicker thresholds, after pre-exposure to ultraviolet, it is obvious that an effect upon visual thresholds cannot be expected, since one is dealing with an irresponsive pure cone population of sensory units with exclusion of the rods. A test of this kind has no relevance to the problem of the presence of an ultraviolet effect upon the peripheral rod units.

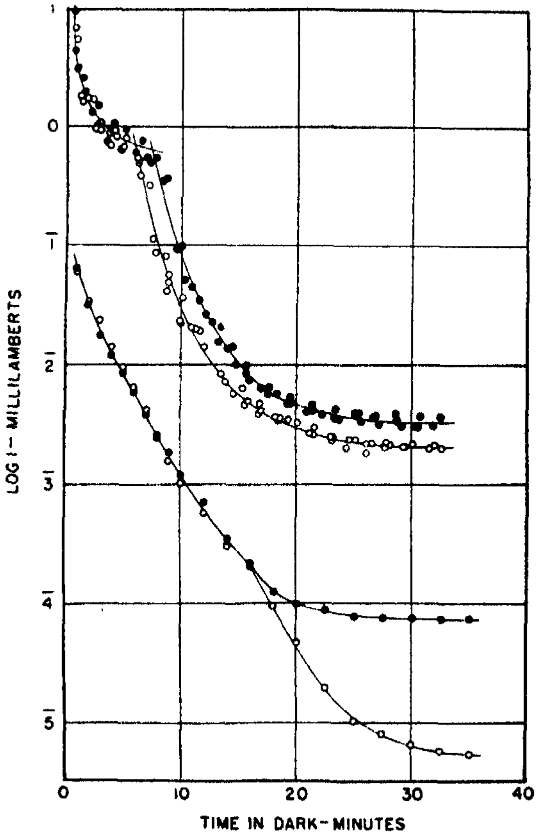

Fig. 1. The course of dark adaptation of human eye (above) and for baby chicks (below) after exposure to the radiation of mercury vapor lamps. Open circles indicate that the ultraviolet has been filtered out; black circles, that ultraviolet above 285 $m\mu$ is present.

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IN THE LABORATORY

Determination of World Plant Formations From Simple Climatic Data

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While attempting to understand relationships between the mountain vegetation of an area in Haiti and other vegetation units of the island and surrounding regions, the literature was searched unsuccessfully for a comprehensive system which presented formations or vegetation units on a relatively equal or comparable basis. To fulfill such a need, a chart (Fig. 1) was constructed which differentiates the vegetation of dry land areas of the world into 100 closely equivalent formations separated by temperature, precipitation, and evaporation lines of equal value.

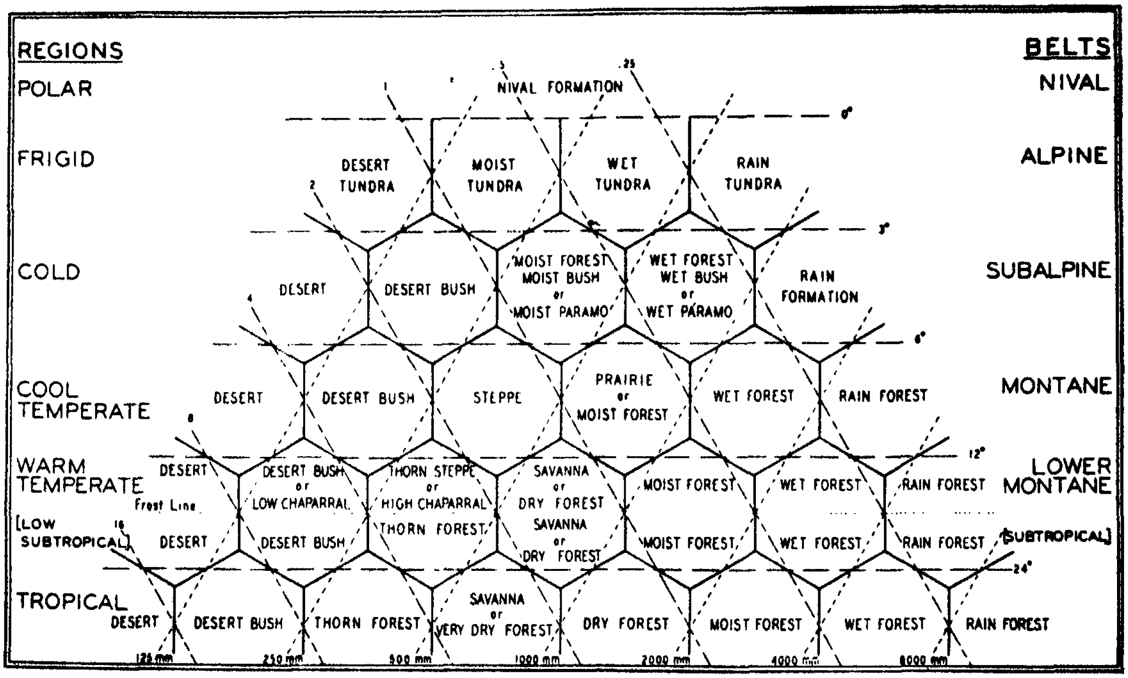

FIG. 1

Mean temperature values used approximate those of the growing season and are determined for specific sites by adding the average mean monthly temperatures greater than 0°C. and dividing by 12. Such values for lower elevations establish several regions north and south of the heat equator, as indicated on the left, and at higher elevations the belts listed at the right. Because of the difference in vegetation caused by the presence or absence of frost in the warm temperate region and the lower montane belt, a frost line is recognized which separates the low subtropical region and the subtropical belt formations as vegetation units usually present between the 24° isotherm and the limits of killing frosts.

The precipitation value used for a locality is the average mean annual precipitation in millimeters. The temperature and precipitation values for any site plotted logarithmically on the chart determine a point which falls within a hexagon representing a formation. When the point falls within one of the border triangles of a hexagon, the vegetation of that area will show a transitional character.

For altitudinal adjustment, approximate elevation in meters above sea level must be known to be certain of the region to which the formation belongs. All altitudinal belts will be found only in the tropics. In other regions, only the belts above the basal formations of the region on the chart will be encountered. Elevations of formation boundaries vary considerably, but the ranges of the belts approximate the following: nival—indefinite, alpine—500 m., subalpine—500 m., montane—1,000 m., and lower montane alone or with the subtropical if present—2,000 m. The tropical basal region varies from 0 to 1,000 m.; the warm temperate alone or with the low subtropical, 0–2,000 m.; and the basal formations of the other regions, from 0 m. to the maximum for the corresponding belt.

Thus, a station below 500 m. in elevation with means of

8°C. and 360 mm. would fall in the cool temperate steppe formation. If the same values were obtained for a station 2,500 m. above sea level, the formation would be warm temperate montane steppe. Formations with common precipitation and temperature boundaries, but occurring at different elevations in adjacent regions, are termed linked formations because they show closer affinities than other adjacent formations separated by temperature or precipitation boundaries.

The evaporation lines are not essential to the use of the chart. These are inserted to show the other balancing factor in the chart, and the values indicated are thought to represent the number of times the actual precipitation could be evaporated in one year at sea-level atmospheric pressure. No data are available to support these suggestions regarding evaporation.

The chart is designed to make broad divisions and to show actual relations between climatic vegetation formations. Local edaphic conditions, such as salinity or a high water table as well as alteration by man, can obviously change the appearance of the vegetation to a great extent. Two or more names were found necessary at times, partly because formations from both low and high elevations are represented on a two-dimensional chart and partly because certain easily determined factors, such as topography in grass or tree formations and the difference between continental- and mediterranean-type climates, make possible vegetations of a distinct appearance under similar climatic conditions. Further details and examples will be given in a paper now in preparation.

Detection of Hypoglycemic Reactions in the Mouse Assay for Insulin

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In 1946 Thompson (*4*) described a sloping-screen technique for use in the mouse assay of insulin. This technique avoids the subjective selection of convulsive animals necessary in the more conventional methods (*2*, *5*) and reduces personnel requirements.

One disadvantage of Thompson's method, as observed in these Laboratories, lies in the fact that the mice do not fall away from the screen until signs of insulin shock are far advanced, and, even though the mice are immediately injected with glucose, the mortality is high.

Fig. 1 shows a unit which was developed in these Laboratories in an attempt to overcome the difficulty noted.[1] The unit consists of 6 hollow cylinders, 8 inches in diameter and 27 inches long, mounted at an angle of 60° on wooden rollers. Five inches of each end of each cylinder is constructed of 22-gauge galvanized iron, and the central section, 17 inches in length, is constructed from ½-inch wire mesh. The wooden rollers, motor driven at a constant speed, make contact with the cylinders through plywood bands which encircle the cylinders 2½ inches from top and base. Each cylinder rotates once every 40 seconds. The cylinders may be removed from the rollers for cleaning and emptying. The unit is housed in a room with a temperature range of 23–25° C.

In performing an insulin assay, mice are injected subcutaneously with suitable amounts of the insulin preparations to be compared and are loaded into the rotating cylinders, each of which will readily accommodate 40 animals. The rotation assures that the foothold of the mice is never secure for long. At the first sign of insulin shock they fall away into trays placed beneath the individual cylinders. These contain rabbit chow pellets, and in almost all cases the mice falling into the trays are able to eat sufficient food to relieve their hypoglycemic signs, so that injection with glucose is unnecessary. When a specified interval has elapsed after injection, the mice which have fallen away from the cylinders are counted, the numbers so obtained being used in computing the required estimates of potency and precision.

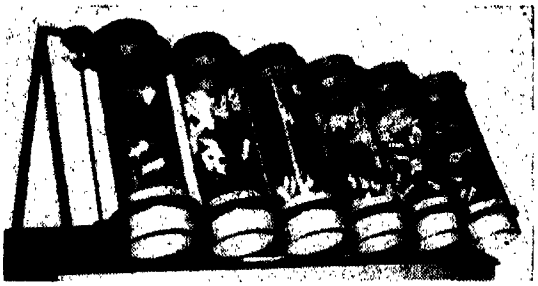

Fig. 1

Results obtained from 35 consecutive assays were utilized in estimating the slope of the logarithm-dosage response relationship. A two-dose technique similar to that outlined by Miller, Bliss, and Braun (*3*) was employed in each assay. The ratio of the higher dose of standard to the lower dose of standard was 2:1 in all cases. The higher dose in the different assays varied from 0.025 to 0.010 I. U. of insulin/mouse. Thirty-six mice were used at each level. In each assay the numbers of reactions which had occurred at 45 and 60 minutes after injection of insulin were noted.

The percentages of animals responding to the two doses of standard were transformed to probits, and the slopes of the logarithm-dosage response curves were computed. The average slopes at 45 and 60 minutes were found to be 3.2 and 3.3, respectively. There was no indication from the χ^2 tests that the slopes varied significantly from one assay to another. The values obtained are of the same order of magnitude as the value 3.5 obtained by Marks and Pak (*2*) and the value 3.0 obtained by Trevan as calculated by Irwin (*1*).

The mortality among the first 18,000 mice placed on test was found to be 1.7 per cent, an appreciable decrease from mortalities of 7–10 per cent experienced in these Laboratories with more conventional procedures. It was found that two operators, using the unit described, could perform all the work necessary for a 1,000-mouse assay in one working day, whereas with the procedure previously used four operators were employed to perform assays of this size. Efficiency was increased somewhat by assaying two unknown samples of insulin (two cylinders per unknown) against one standard (two cylinders) on each run.

It is reasonable to suppose that the apparatus might also be employed to assay compounds counteracting the action of insulin (cortical and pituitary hormones), central nervous system depressants (anesthetics and hypnotics), and compounds affecting neuromuscular transmission (curare), as well as in studies relating to the development of tolerance to certain drugs.

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[1] The authors wish to express appreciation to W. Parkinson and D. P. Joel for technical assistance in construction of the apparatus.

In assaying drug samples of unknown origin by means of the apparatus described, special attention will have to be paid to the qualitative relationship between unknown and standard material. The results of an assay will be misleading if the mice react to some agent in the unknown preparation other than the specific substance under study.

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Apparatus for Mustard Gas Treatment[1]

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The early work which led to the discovery that mustard gas could induce mutations in *Drosophila melanogaster* as efficiently as X-rays was carried out by pumping mustard gas dissolved in cyclohexane at intervals into air flowing past the flies (*1*). This method was rather unsatisfactory, as apparently similar treatments gave widely discordant results, and a few accidents occurred among those handling the mustard gas. The new apparatus to be described has several advantages over the old: (1) Dosage is controlled and repeatable; (2) a single charge of mustard gas lasts for many experiments; (3) contact with mustard gas is avoided except during recharging; (4) another substance in addition to mustard gas is not used; and (5) the apparatus is ready for use at any time.

The following train attached to an aspirator is set up in a fume cupboard: air intake with cotton-wool filter; tap; bubbling device (two potash bulbs) containing pure mustard gas; three-way tap; trap; *Drosophila* vial; trap; wash-bottles containing HNO_3. The aspirator consists of two winchester quarts fitted in series in the usual way. Rubber connections are employed throughout.

The insects are exposed by placing them in a clean, empty vial in the apparatus and turning the three-way tap to admit air. When the rate of flow of air through the wash-bottles has been adjusted (about 3 bubbles/second), the taps are turned to admit the air via the mustard gas. This air is saturated with mustard gas vapor, and the amount depends (but only slightly) on the temperature. Using Florida-4, an inbred stock, at a temperature of approximately 10° C., the flies show some discomfort after about 8 minutes, after 20 minutes do not often travel the entire height of the vial, and after 30 minutes a few remain motionless on the bottom of the vial. At the close of the run, the two-way tap is shut, and the three-way tap adjusted to admit air. A period of about 10 minutes is allowed to wash away all traces of mustard gas. The flies rapidly recover when the mustard gas is no longer admitted. During the run, the operation of the wash-bottles and bubblers causes the air flow to surge; this is regarded as an advantage, as it ensures thorough mixing of the air in the exposure chamber.

If a large number of flies is used, the vial becomes very moist, because the flies excrete much fluid when the mustard gas reaches them. If a piece of coarse filter paper is placed in the vial, most flies rest upon this, and the moisture is absorbed and evaporates more easily in the air stream.

As originally designed, the concentration of mustard gas in the air stream could be raised by heating the bulbs and thus increasing the vapor pressure of the mustard gas. To prevent subsequent condensation, the first trap and fly vial must then be raised to the same or a greater temperature. No need was found for this arrangement, however, and all dosage work has been performed by varying the time of exposure.

Of course, this arrangement controls only the external concentration of mustard gas. The amount which reaches the nucleus of any organ will vary, due to differences of chemical composition of the organ and consequent solubility of mustard gas. Though constant for similar organisms, the apparatus cannot, like X-ray machines, deliver an equal dose to the nucleus of all nuclei of any species exposed in the same way.

With this apparatus, Florida-4 males exposed for 15 minutes show about 5 per cent sex-linked mutations, using the ClB test.

Reference

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[1] All expenses in connection with this work were borne by the British Empire Cancer Campaign.

Acetone-desiccated Adult Tissues as a Source of Cell Growth-promoting Extracts

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During the course of our studies on the growth-promoting effect of adult tissue extracts on cell colonies *in vitro*, it became obvious that a starting material combining the characteristics of stability, uniformity, and easy sterilizability would facilitate the continuation of the work and obviate the tedious necessity of preparing extract under sterile conditions, from freshly removed tissue, each time a new experiment was contemplated. Acetone-desiccated adult chicken hearts were found to constitute such a material.

The procedure used was as follows: Hearts of adult chickens were packed in ice and sent to the laboratory as soon as convenient. Following gross dissection in order to remove the large vessels and fat tissue, the hearts were "homogenized" in a blender with as little physiological saline solution as possible to allow for smooth running of the machine, and the resulting mash was mixed with five times its weight of acetone, previously cooled in the icebox. The mixture was left in the icebox for 30 minutes, rapidly filtered with suction on a Buchner funnel, washed with a little cold acetone, and again extracted for 30 minutes with acetone, using in this and in all the following extractions a weight of acetone equal to the weight of the original batch of hearts. In all, four extractions were made After the final extraction the material was ground in a mortar, spread out on an evaporating dish, and freed of the last traces of acetone and water by keeping it from 24 to 48 hours in a large, evacuated desiccator, over $CaCl_2$ or H_2SO_4.

The yield of dry substance is about 18 per cent of the weight of the fresh hearts used. The material is a very light, tawny-colored powder containing many fibers that remain unpowdered.

For the purpose of sterilization the powder was transferred, in amounts of 1–2 grams, to sterile, large, cork-stoppered centrifuge tubes, the tubes filled with acetone for 1–2 hours, and centrifuged. The excess acetone was pipetted off under sterile conditions and the tubes left overnight in a desiccator *in vacuo* to get rid of the acetone. The powder was then transferred with sterile precautions to ampoules which were sealed *in vacuo* and kept in the icebox.

Whenever heart extract is required, a sample of the powder is extracted for 24 hours, with 22 volumes of Tyrode's solution diluted with enough distilled water to obtain a final isotonic extract. In this way an extract is obtained which in its water content corresponds to that from an equivalent weight of fresh hearts made by our standard method (*2*). The extract from the dried powder, just as the fresh extract (*1*), can be diluted with an equal volume of Tyrode's solution without apparently diminishing its growth-promoting effect on cell colonies.

TABLE 1

Comparison of the Sizes of Culture (mm.^{2}) Grown for Six Days in the Presence of an Extract of Acetone-desiccated Chicken Hearts (A) and in a Protective Medium (Tyrode's Solution) (B)

No. of culture	A	B
12203	97	8
12204	100	7
12221	96	5
12222	88	4
12223	96	13
12224	134	20
Average....	101.8	9.5

The tests of growth-promoting power of the extract from acetone-desiccated tissue powder were made on standardized cultures of fibroblasts in Carrel flasks. The solid phase of the medium consisted of 0.5 ml. of chicken plasma and 1 ml. of Tyrode's solution coagulated with 1 drop of dilute embryo extract, while the liquid phase consisted of 1 ml. of the solution to be tested. The tests were always performed by comparing the growth of the two sister halves of a single standard culture.

It was found that the extract from the acetone dried heart powder has intense cell growth-promoting power, producing cultures with areas about 10 times as large as those of cultures growing in a protective medium (plasma + Tyrode's solution) (Table 1). A comparison of the growth-promoting effect of this extract with that of fresh adult heart extract, using both in standard concentrations, shows that the former is somewhat more potent (Table 2).

TABLE 2

Comparison of the Sizes of Culture (mm.^{2}) Grown for Six Days in the Presence of an Extract of Acetone-desiccated Chicken Hearts (A) and an Extract of Fresh Chicken Hearts (B)

No. of culture	A	B
12205	80	40
12206	92	50
12209	80	96
12210	114	105
12225	94	50
12226	80	68
12337	115	72
12338	116	65
12341	96	88
12342	88	58
12375	63	52
12376	80	72
12379	51	64
12380	45	58
Average	85.3	67.0

Samples of acetone-desiccated chicken hearts have now been kept for five months and still fully retain their original activity.

An identical procedure performed on adult chicken brains has yielded a dried brain powder giving an extract with the same cell growth-promoting properties as extracts of the original brain tissue.

Acetone desiccation of pulped chicken embryos of various ages (8–18 days of incubation) has also yielded a dried powder which provides a growth-promoting extract as active as fresh chicken embryo extract made from the corresponding amount of fresh embryos.

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Oral Administration of Small Doses of Liquids to Laboratory Animals

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The problem of feeding small quantities of substances, especially liquids, to laboratory animals is of importance in many experimental procedures. Feeding from dishes has certain undesirable features, such as failure of animals to consume the dose completely and exposure of the material to destructive and contaminating effects.

Stomach-tube feeding as described by Marks (*2*) and recently by Lehr (*1*) is used widely but has some disadvantages. Considerable experience and skill are necessary with metal-type tubes to avoid injury to animals. Rubber tubes are sometimes cut by animals' teeth, and slight pressure on rubber and silk tubes results in variation in the amount of material delivered. This is especially undesirable when small amounts of relatively concentrated solutions are being fed. Lehr has discussed the disadvantages of using the wooden, central-hole mouth gag.

The apparatus described here is simple to assemble from parts available in most any animal laboratory. Experience has shown it to be efficient and useful in feeding certain types of solutions, such as oil solutions of carotene and vitamin A. It is adapted especially to feeding small doses when relatively accurate measurement is required.

The apparatus (Fig. 1) consists of a ring stand on which is mounted an ordinary test tube holder in which is fastened a "tuberculin" syringe. Below this a blunt dissecting forceps is clamped in position so that the end of the syringe needle is directly above (about ½ inch). Obviously, a "hairpin" type of gag made from wire or small-diameter glass rod may be substituted for the forceps. However, the forceps has proved to be more satisfactory. Tension can be varied so that it can be adjusted to fit into the mouth of any size rat by adjusting the screw of the ordinary clamp holder, fastening it in position (Fig. 1).

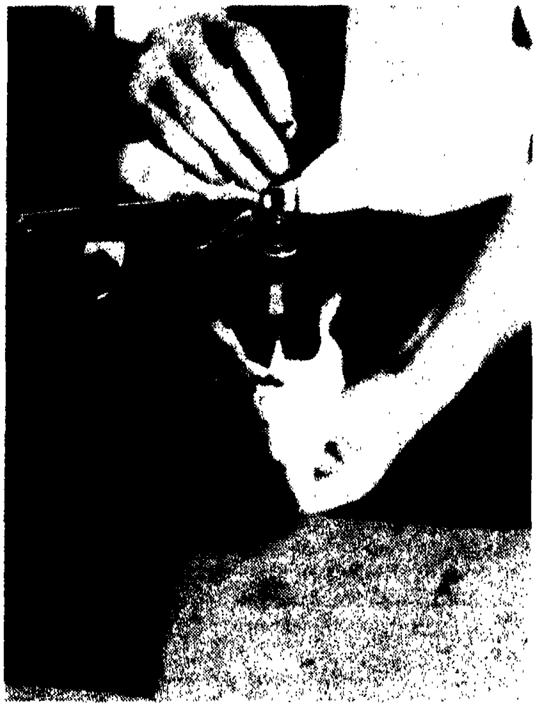

Fig. 1. Apparatus for drop feeding rats without assistance.

In feeding animals the syringe is filled with the desired quantity of material and placed in the test-tube holder. The animal is grasped with the left hand; ample amounts of skin from the neck and back are held as shown in Fig. 1. With aid of the right hand the forceps is inserted in the animal's mouth. The right hand is then moved to operate the syringe and the feeding is dropped into the open mouth. Fig. 2 illustrates how the tongue should be held with forceps in order to produce a proper opening to receive the liquid. The animal can be immobilized by wrapping in a small towel (*1*), but this is not necessary with the strain of rats used in this laboratory. If the neck skin is held with a firm grasp and the forceps inserted carefully to avoid hurting, there is no inclination on the part of the animal to struggle. The rat invariably swallows the solutions without ejecting them from its mouth. Many substances which the animal will not consume voluntarily can be fed in this manner.

Solutions may be fed as measured by calibration marks on the syringe, or drop weights may be calibrated. Although drop weight is affected by many variables, such as temperature of solution, time required for formation of drops and angle of needle, these factors can be standardized closely enough to insure uniform results. It will be found that counting a given number of standardized drops offers certain advantages in speed and accuracy in some feeding problems. Incidentally, clamping of the syringe in a vertical position, as shown in the figure, eliminates the variable due to holding the needle at different angles while feeding drops.

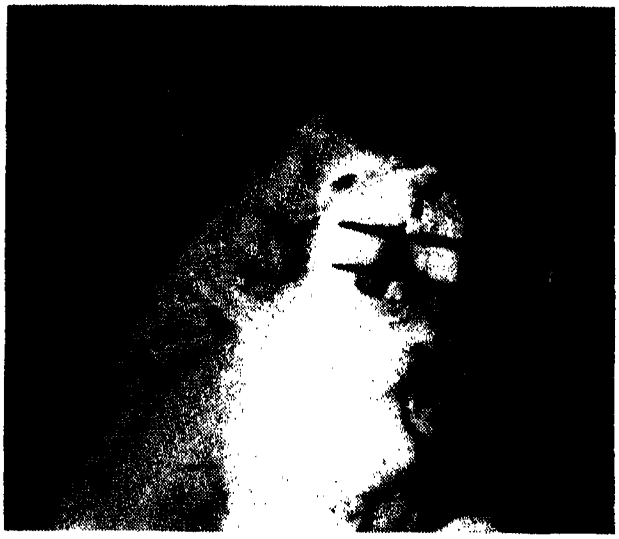

Fig. 2. Position of forceps for drop feeding.

Variation in size of drops can be controlled by using different size needles. The use of a timer with a long sweeping second hand is desirable to standardize timing of drops.

Concentrated solutions make smaller feedings possible and eliminate continual filling of the syringe. Very rapid feeding is possible, especially if the solutions fed are relatively concentrated. For instance, it has been found that an operator can remove an animal from its cage, feed 1–3 drops of solution, and return the animal to its cage in 10 seconds. This is probably faster than would be the case in actual practice, but it gives some idea of what can be expected when using the procedure.

The most desirable feature of the apparatus is that the necessity of an assistant for holding aminals is entirely eliminated. One operator can work practically as fast as two, without sacrifice of accuracy or damage to the animals.

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Book Reviews

Trace elements in plants and animals. Walter Stiles. Cambridge, Engl.: at the Univ. Press; New York: Macmillan, 1946. Pp. xi+189. (Illustrated.) $2.75.

In the past two decades a tremendous literature has been amassed around the subject of so-called trace elements in soil-plant-animal interrelations. A recent compilation of abstracts includes over 7,000 references to published articles. Different as the approaches and points of view of these diverse publications are, they deal with several inorganic elements, all of which are involved in the economy of the living organism in very minute amounts.

It scarcely requires mention that so vast a literature is hardly manageable not only by the student of general plant and animal physiology but even by many workers in the field. Prof. Stiles has attempted to prepare within the limits of a small monograph, a digest of the significant developments in this field of knowledge. He has succeeded admirably in this undertaking and has produced a concise and lucid review of the salient facts underlying both the laboratory and the field aspects of the subject.

Following an historical introduction, thorough treatment is given analytical methods and nutrient culture procedures, so crucial in a field of experimentation in which micrograms and parts per billion are common units of measurement and distilled water and CP chemicals are almost invariably "contaminated" and cannot be used without further purification. The author has wisely stressed principles rather than minutiae of procedure, yet his discussion is thorough. In discussing micronutrient deficiency diseases of plants, individual sections are devoted to manganese, zinc, boron, copper, and molybdenum. In the chapter on animal nutrition, attention is given to disturbances traceable to either excess or deficiency of an element. Considerable space is assigned to the functional aspects of micronutrients as reflected by reciprocal relations of different nutrients. An extensive, yet selective, list of references is appended.

The discussion of functional aspects reflects the inadequate state of knowledge of this phase of the subject. Whatever precise information is available comes from the enzyme chemists concerned with metalloproteins. More generous treatment could have been given to the copper enzymes, with a discussion of laccase and ascorbic acid oxidase. The author, however, seems to have in general placed the biochemical aspects of the subject beyond the scope of the monograph.

It would be unreasonable to expect more material within the covers of so small a volume, yet the reviewer cannot refrain from wishing the author had considered some criteria for including a given element in the list of essential nutrients. Proposals will, no doubt, be made in the future for enlarging the list of essential elements, and the judicious evaluation of evidence in the light of some definite criteria of essentiality would be helpful.

These remarks are in no way intended to detract from the value of the book to investigators and students of soil science and plant and animal physiology. The monograph should also prove of importance to biochemists as a useful and concise review of interesting problems in inorganic nutrition which as yet await elucidation.

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Gall midges of economic importance. H. F. Barnes. London: Crosby Lockwood, 1946. Vol. I: Pp. 104; Vol. II: Pp. 160. (Illustrated.) 12/6 and 15/-.

These first two volumes of a series designed to cover a comprehensive study of the gall midges of the world are subtitled *Gall midges of root and vegetable crops* and *Gall midges of fodder crops*, respectively. Volume III, *Gall midges of fruit*, and Volume IV, *Gall midges of ornamental plants and shrubs*, are to be published later. The author also projects subsequent volumes on gall midges of trees, cereals, weeds, miscellaneous crops such as beverage plants and herbs, and midges which are zoophagous and fungivorus.

C. T. Gimingham, of Harpenden, gives a foreword to the series in the first volume, and each volume has a special introduction as well as a very complete list of the literature of the subject matter, which is materially enhanced in usefulness by an index to gall midge names, a plant index, and a general index. Over 60 species of midges are covered in the first volume, while more than 160 species are included in the second. The writing is smooth and pleasant, making the books very readable. Each volume is complete in itself.

Gall midges include such insects as the Hessian fly, chrysanthemum midge, pear midge, clover seed midge, and many other important midge pests which the author still recognizes as the Cecidomyiidae but which in America we generally term the Itonididae. Generally speaking, the family is herbivorous, but a considerable number of the species are zoophagous.

The material is arranged under the food plants, which appear in alphabetical order. Although the less important insects are not set off distinctly, the index helps to overcome this difficulty. This fault, however, makes the books less valuable as a reference work. The arrangement of items under the important species of insects is excellent. First, there is a paragraph on diagnostic characters, which is followed, in order, by a general description, a complete distribution, and paragraphs on life history, food plants, natural enemies, and control. The author closes each volume with a reference to specimen material used and cites the more important literature relating to the species.

There are a number of illustrations, mostly photographic, with some colored plates, but these do not add much to this excellent work. Barnes has brought together a wealth of information in a group generally neglected by economic entomologists, and his work should be a stimulus to others to investigate the Itonididae.

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Fundamental Research in the Clinical Specialties

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THE SUCCESSFUL OUTCOME OF GOVernment-supported research during the war has focused the attention of the public as well as professional groups on the desirability of continuing a part of this activity. Bills to provide funds for research in various branches of science are now before Congress. That these bills have not passed perhaps reflects the divergence of opinion of scientists on the details of administering potential funds rather than the temper of the people on the question of public support of research. It seems possible, therefore, that in the future Congress may appropriate funds for general research purposes. Although lack of funds is one of the chief factors limiting additional research, a comprehensive plan by which expansion may be carried out is just as essential as ample financial support.

In order to determine the present status of fundamental research in the clinical specialties and the readiness of clinical laboratories for expansion when more adequate financial support is provided, the writer has visited a number of medical schools. In general, the impression was obtained that research teams adequate to cope with the fundamental problems in clinical medicine are few. This was confirmed by many of the clinical men interviewed, who expressed dissatisfaction with the present lack of teamwork between clinician and scientist in basic research.

Among the points studied particularly in arriving at this conclusion were: (1) the organizational methods by which research is conducted; (2) the magnitude of the research; and (3) the extent to which the needs of the particular clinical specialty are fulfilled.

Only the larger university medical schools were visited, since it might be presumed that fundamental research would be conducted in these universities on as large a scale as anywhere in the United States. The schools were located along the Atlantic Seaboard, in the Middle West, and on the Pacific Coast.

Typical of the conditions discovered is the situation in a clinical department of one of the midwestern universities. The head of this department is well known in his field. Clinical facilities appeared to be excellent, and space is available for making experimental studies. However, since the termination of a large grant five years ago no full-time investigators have been employed. Members of the clinical staff go to the laboratory occasionally and conduct occasional experiments as a part-time activity. No men from departments of basic science, such as bacteriology or biochemistry, have been assigned to work in the department. Plans have been made to obtain a research director who would be expected to devote half time to coordinating studies made in the department, a quarter to private practice (the income from which would comprise a significant fraction of the research budget), and the remaining quarter to work of his own choice.

Another instance which is not typical but which illustrates the consequences of halfway measures is the situation in a department located in a teaching hospital in a large medical school in the East. The department head is a clinician who previously gained an international reputation for his research work. Unlike that of most men in this position, his salary is adequate to allow him to devote full time to the department—in fact, the position was especially created so that he might have more opportunity for institutional activity, particularly for the "luxury" of research. When asked whether, under these apparently favorable circumstances, the research in his department was developing satisfactorily, his unhesitating answer was "no." Although he believed that the provision for full-time academic work was a step in the right direction, he estimated that 90 per cent of his time was taken up with such administrative duties as obtaining new house officers, making rounds, settling petty squabbles, and numerous other details requiring the attention of a department head. Moreover, research by others on the staff is sporadic; an excellent young investigator was recently forced to enter private practice to make a living wage. The only full-time studies being conducted at present are carried out by a single investigator, a chemist.

In the two departments described definite efforts have been made by capable administrators to conduct research programs within the departments, but these have failed in their objective because of lack of funds. In departments in other institutions visited, no fundamental research has been attempted, and no facilities or personnel are available.

A method of conducting research which is being used increasingly is to assign members from departments of basic science to the clinical department or vice versa. Salaries and duties are divided. In a few instances this method has proved successful; more often the complaint is heard that the clinical man is unsympathetic with the choice of problem and that little actual contact exists between the basic scientist and the clinician, who spends most of his time in private practice. A variation of this arrangement is for the clinician to consult, either by periodic conference or when the occasion arises, with men in the preclinical departments. With the exception of one institution, where periodic conferences were implemented with laboratory work performed by full-time investigators, it was evident that this arrangement produced little more than conferences. The principal weaknesses of the conference method lie in the lack of mutual understanding and time, existence of other interests, and minor annoyances encountered in a joint investigation with busy co-workers frequently located on the other side of town.

Some research in clinical specialties is done in the basic science departments; these researches frequently lack continuity and are often of an analytical nature. As such, they are of great value. However, the mere accumulation of facts is not sufficient; it is important, in addition, *to use them to establish new principles* or to confirm old ones. This is an endeavor which requires background and insight both in the basic sciences and in the clinical field in which known facts are to be used.

In addition to research in medical schools and associated hospitals, an increasing number of studies, particularly in medicine, are being conducted in research institutes and industrial laboratories. Despite obvious limitations, the majority of these are well organized and are performed by trained full-time workers. The clinical testing for both groups must be farmed out to nearby hospitals.

It is impossible to obtain an over-all picture of fundamental research in medicine without taking into account the increased emphasis placed on studying separately such diseases as cancer, tuberculosis, poliomyelitis, arthritis, and those affecting the heart. While these diseases are also the concern of different clinical specialties, they represent single entities, and the study of each is likely to become a specialty.

The number of people working in a given field is small indeed. This is illustrated by an example chosen from the specialty with which the writer is particularly acquainted, namely, ophthalmology. Glaucoma is caused by excessive intraocular pressure, which if untreated, results in blindness through excavation of the optic nerve head. This disease is the chief cause of irrevocable blindness in individuals past middle life and is typical of the dramatic type of illness which might be expected to stimulate research. How many investigators in the United States are devoting half or more of their time to studying glaucoma? Or, more important, how many are investigating basic physiological processes in the eye which might lead to a successful therapy? A generous estimate is *three.*

It is concluded from the information obtained that many halfway measures are being employed in an attempt to carry out research programs in the clinical specialties. As a result, the amount of fundamental research in the clinical field is extremely small in comparison with that in the preclinical sciences. Of the persons interviewed, all but one is dissatisfied with the present state of investigational activities in his field, the exception being a man ready to retire. The implied excuse for this deficient state is a lack of funds available over an extended period. Not only is basic research undeveloped in these fields of medicine, but it is apparent that if sufficient funds to carry out an intensive research program were immediately forthcoming, few departments have any trained personnel or well-laid plans for their effective use. This condition can be attributed in part to a defeatist attitude born of previous unsuccessful attempts to overcome the multiple difficulties inherent in combining an extensive research program with teaching and running a successful clinical department. It seems appropriate, therefore, to consider measures which might remedy this situation.

PROGRAM FOR EXPANDING RESEARCH

One way to expand research is to increase the number of laboratories investigating specific diseases. The inherent emotional appeal and the ease with which such programs can be delineated are strong tactical arguments in favor of this method. The disadvantages, particularly with small projects which may be forced to advertise their progress, are less apparent but just as real. There is danger, for example, that the interests of research workers may become narrow, that promising leads in the solution of other problems cannot be exploited, and that the feeling of constant pressure to turn up a "cure" may stimulate "long-shot" experiments at the expense of sound but more methodical investigations.

Another means of furthering research in clinical specialties is to establish research institutes in which investigations relating to a number of specialties could be performed. This method offers no appreciable advantage over the one to be recommended and entails considerable duplication of existing facilities and personnel.

A sounder plan, which does not call for significant changes in administration or physical layout, is to establish laboratories staffed with well-trained, full-time workers in the clinical departments of university medical schools. The objective is to develop the fundamental aspects of the clinical specialty and make these available to the postgraduate student. This method is not novel, since it has been successfully carried out over a period of years in the Howe Laboratory of Ophthalmology. Experience gained in this laboratory should be useful in considering a more widespread application of this method.

Historically, there has been little precedent for full-time investigators in clinical specialties; however, the tremendous developments in the basic sciences have suggested many new approaches to the solution of medical problems. These have complicated inordinately the methods of doing research. Whereas in the past many studies leading to fundamental discoveries have been made by isolated workers devoting their leisure time to research, present-day experience indicates that most progress comes from the cooperative effort of individuals having different training and background. Research of this kind is essentially a full-time job if facilities and personnel are to be utilized efficiently and if the quality of the work is to compare favorably with that in other branches of science.

The Laboratory for Fundamental Research

The first step in establishing a research laboratory is to secure the services of an able director. At first thought it may appear that the head of the clinical department should also be the director of the research laboratory. This is inadvisable, however, because: (1) directing a laboratory is a full-time job; (2) the person in charge of a clinical department is usually interested chiefly in the practice of medicine rather than in basic research; (3) the head of a clinical department frequently lacks the scientific background which would qualify him to direct research; (4) the clinical professor may be inclined to encourage studies with immediate practical application rather than those of a more fundamental nature; and (5) the demands of his practice would pre-empt both the time and attention of the clinical professor. Actually, both positions are of such importance and involve functions so separate that a parallel rather than a vertical administrative organization is desirable.

The qualifications of the laboratory director should include a sound basic training in either medicine or science, a broad general interest and background in research, and, if possible, administrative experience. It is of greatest importance that the director be wholly in sympathy with the idea of a laboratory in which appropriate problems in basic science are investigated for the purpose of advancing a medical specialty.

A competent staff is no less important for the laboratory. Before selecting a staff it is necessary to recognize that its primary function is to conduct studies of a fundamental nature, not merely to be concerned with case-history reports, statistical studies, and the delineation of techniques.

In recent years advances in clinical medicine have paralleled great developments in the basic sciences. The growth of knowledge in both fields has been so extensive that to become a clinician, a physiologist, or a bacteriologist is a major achievement. Few individuals receive additional training or possess experience outside a single specialty. Accordingly, since the purpose of the research organization is to employ the concepts and techniques of the fundamental sciences in the investigation of problems in clinical medicine, it is essential that the staff include some individuals trained in preclinical sciences and others trained in a clinical specialty.

Each member of the staff should be prepared to conduct independent research and to work on equal terms in cooperative investigations whenever this is to mutual advantage. This type of organization assures that the scope of the work will be more broadly representative of the specialty, permits greater flexibility in the choice of problems, and takes advantage of the combined talents of the staff as a whole. That these talents consist of more than technical skill is not always appreciated. For example, the function of the preclinical scientist in research is frequently assumed to be merely that of a "glorified" technician. This was illustrated recently by the comment of a man who wanted to promote research in his clinical department. He said that what he "really wanted" was a biochemist who could perform analyses, the implication being that the success of a well-developed research program depends exclusively upon the performance of analytical work. In this kind of thinking, emphasis is on the results of analysis and not on the fundamental concepts which are prerequisite to intelligent interpretation. To this man, who is representative of many well-known clinicians of the older school, a person trained in the basic sciences is merely an adjunct to the laboratory whose scientific acumen is disregarded entirely and whose technical services are overrated. In this instance, the mistake is not in obtaining a biochemist but in misunderstanding completely his function in the laboratory. Therefore, to utilize the basic scientist fully it is essential that, in addition to using his technical skill, his intellectual capacities and talents be directed toward the conception and solution of research problems.

Following the same reasoning, the knowledge which clinically trained men possess concerning normal and disease processes should be applied to the solution of basic problems as well as to those of clinical significance.

The recommended individual approach to experimental problems may not appear possible in view of the limitations of specialized training already discussed. Actually, this may be true, but only during the initial stages of development. One of the chief attributes of an organization of this type is the day-to-day association of scientists and clinicians which eventually leads to mutual understanding of both fields. This, in turn, develops in each worker the ability to think in terms of both the clinical and scientific aspects of a problem. It is only when this point is reached that each member of the group is able individually to pursue effective independent research, and the laboratory as a whole is competent in all major phases of a specialty.

A secondary function of the staff is postgraduate teaching of basic science applied to a medical specialty. The laboratory staff should have the same teaching relation to the clinical specialty as the staff of the preclinical department has to medicine as a whole. For example, physiology might be limited to physiology of the eye or the urinogenital system, as the case may be. Experience in different branches of the specialty pre-eminently fits the laboratory staff for this task. It may also be desirable for the staff to assist in postgraduate teaching in clinical subjects, but all teaching should be so arranged that it does not occupy over approximately a quarter of the staff's time; in any case, it should not be permitted to bring research to a standstill.

The number on the staff will vary with the physical facilities of the department and with the financial support, but three is probably a minimum number for an effective unit, and four or five is better.

A laboratory staff in neurology, for example, might include two clinicians having different research interests, a physiologist, an anatomist, and a biophysicist. Arrangement should be made so that other members of the clinical department and investigators who might be assigned from cooperating preclinical departments could also participate. Temporary associates supported by term grants could assist the research group. Adequate technical assistants, secretarial aid, and an animal room attendant should also be provided.

If the laboratory unit is to function effectively, and if mistakes which in the past have resulted frequently in scanty and mediocre research are to be avoided, special consideration must be given to academic standing, remuneration, and tenure of the staff.

The system of rank in most clinical departments differs significantly from that in preclinical departments. It is customary in the former to have a professor, one or more assistant or associate professors, and a much larger number of assistants and instructors. In most instances the latter devote but a small fraction of their time to teaching and little or no time to research; they may continue without advancement in rank for life. Many of the men holding these lower ranks are outstanding physicians in the community, and their reputations are independent of their academic rank in the medical school.

In the preclinical departments, on the other hand, the staff ordinarily is much smaller and consists chiefly of men who devote full time to academic work. The same system of rank prevails, but the assistants, instructors, and usually assistant professors are young men. For them, rank determines their standing in the profession.

Since the staff of a fundamental research laboratory consists of career men, their academic status should be comparable with that of career men in other academic fields rather than with that of their co-workers in clinical medicine. In order to describe more accurately the type of work performed and to avoid the appearance of discrimination, it is preferable that the titles of the laboratory staff be different from those of the clinical staff, e.g. professor of neurological research, on the one hand, and professor of neurology, on the other.

The income of men in research does not approach that of the average practicing physician. If qualified physicians are to be attracted to medical research, a reasonable salary and satisfactory security in tenure is essential, particularly if they are to remain in this vocation. Salaries must compare favorably with those offered in basic science departments and in industrial research laboratories.

In such matters as academic standing, remuneration, and tenure the policy of the research laboratory may well be patterned after that of the preclinical rather than the clinical department. In problems of organization, on the other hand, this is not true because of distinct differences in personnel. For example, the staff of a biochemistry department ordinarily consists solely of biochemists, that of a bacteriology department only of bacteriologists, etc. In contrast, the complexity of fundamental research in the clinical field requires a staff of individuals from various fields. Strict adherence to the vertical system of departmental organization common in academic departments is unsuitable for the small staff of the laboratory. This is not to say that the usual academic advancement through the ranks should be abandoned, but to point out that as each staff member becomes, through experience and accomplishment, an authority in his own right, he should be rewarded with the rank and salary that he might have had if he had remained in his original specialty.

With rising costs, a budget for a laboratory involves some uncertainty. However, approximately $12,500 to $15,000 per year per staff member is probably a good estimate. This amount should cover salaries for the staff, technicians, secretaries, diener, and machinist, and the cost of animals, supplies, and equipment. A laboratory consisting of four staff members would require between $50,000 and $60,000 per year.

It is pertinent now to discuss several less tangible matters of importance in establishing research laboratories in the medical specialties. First, if the basic scientist devotes sufficient time and effort to becoming familiar with both the medical and scientific aspects of a specialty, it is possible that he may not be able to maintain in each the same proficiency as the more specialized individual. It has been said that he is neither fish nor fowl. This criticism might well have been made about the biologist or chemist who first transcended the horizons of his specialty to become a "biochemist," but few would deny that this "hybrid" has contributed more to the development of biochemistry than has the biologist and the chemist. The great contributions to the advancement of knowledge in the scientific aspects of medicine may well come from another "hybrid" who might be called the "medical scientist."

Secondly, in leaving an established field such as clinical medicine or basic science to work in a relatively new, composite field, the staff may experience a degree of professional isolation. If the laboratory is located in a hospital away from preclinical departments, this feeling of isolation is likely to be more acute in the basic science.

It may be reduced by more positive recognition from the clinical staff of the department, by association of the basic science group with members of the preclinical departments, and by the formation of professional organizations created for workers in the special field. Membership in most medical groups is limited to those with a degree in medicine. Since the prime reason for this limitation concerns the practice of medicine, which is not involved, some special status in the local or regional organization covering the specialty should be created for the nonmedical members of the laboratory. This would be mutually advantageous, since it offers opportunities for professional contact and provides means by which clinical members may keep abreast of recent developments in the more fundamental aspects of their specialty.

As interest in fundamental research in the clinical specialties increases, societies for the exchange of papers, and possibly special journals, provide other ways of reducing the isolation. The trend in this direction is illustrated in ophthalmic research by the formation of the Association for Research in Ophthalmology, Inc., and by plans for a special technical section in an ophthalmological journal.

SCOPE OF THE PROGRAM

The number of laboratories necessary to bring fundamental research to a state of development comparable with that in other branches of science is dependent upon the number of clinical specialties involved, the proportion of total investigational activity in the fields for which these laboratories might assume responsibility, and the special requirements of any given specialty.

Although departments representing every clinical specialty were not visited, a definite need for increased basic research was expressed in the following fields: dermatology, medicine, neurology, ophthalmology, orthopedics, otolaryngology, pediatrics, and urology. Since several others might be added to this list, a total of 10 specialties is a reasonable estimate.

It is beyond the scope of this paper to discuss the research needs of all of the specialties or to attempt a close estimate of the proportion of the total research in any one of these fields which ultimately might be performed in these laboratories. However, in ophthalmology four such groups might well be organized. If this specialty is reasonably typical of the average, the number of research laboratories in all of the fields would be of the order of 40. On the basis of the budget previously given, this would call for an annual expenditure of approximately $2,500,000.

IMMEDIATE OBJECTIVES

The financial requirements of the proposed program may appear to present insurmountable difficulties to any action which could be taken without government support. Furthermore, because of the undeveloped and unorganized state of basic clinical research, it would be premature to attempt to put into operation so comprehensive a program or, indeed, any alternative plan comparable in scope without a preliminary test on a smaller scale. To this end, steps should be taken now to set up one research group in each of four specified clinical fields to serve as nuclei around which expansion could be planned. These four laboratories would cost approximately $250,000 per year and should be planned for a minimum period of 8 years, making a total expenditure of about $2,000,000. They need not be located in the same university, but the existence of a central authority to coordinate the whole effort and maintain unity of purpose is essential. In operating these test laboratories information would be obtained concerning the effectiveness of this method of conducting research which might well transcend in importance the scientific results. However, the latter alone should more than compensate for the effort made.

Provision should be made at specified intervals to evaluate progress in these laboratories. This evaluation and plans for enlarging the program might be made by the sponsor in cooperation with an independent board created for the purpose.

The immediate questions are: What means are available for establishing four initial laboratories, and who would be responsible for such action? It might appear that government support is the logical answer. However, except in those fields of interest which fall within the domain of the War or Navy Departments or the Division of Public Health, few governmental funds are yet available for general distribution to medical laboratories. Since the research interest of the proposed program does not coincide with that of these government agencies, private support must be obtained. This is not without its advantages, as the greater flexibility and altruism permitted by private foundations are especially valuable during the formative period of a new venture.

In general, funds may be sought from three main sources: private individuals, public subscription, and foundations. They may be in the form of outright endowment or periodic contributions.

Appeals to private individuals and the public have proved successful in obtaining funds for studying cancer, poliomyelitis, and tuberculosis. There are two drawbacks to the use of this method for establishing the four test laboratories. First, an appeal to the public requires a highly organized campaign which depends on a previously existing organization; secondly, since most laymen and many nonlaymen do not understand the broad aims of fundamental research, the response is likely to be poorer than it has been when money was solicited for investigation of specific diseases.

There are numerous foundations whose purpose it is to further medical research. The history of medical education and research relates many instances in which the successful inauguration of a new venture depended upon receiving financial support from a foundation. The proposed program probably is no exception. However, its financial needs pose new questions to the foundations, for large sums are required over an extended period. In the past, most foundations have given only relatively small sums for specific projects and for periods rarely exceeding five years. The prospect of obtaining the requisite funds for establishing fundamental research laboratories in clinical medicine may depend upon the degree in which the foundations will allow precedent to influence their present policy. Whereas this policy may well have been a wise one in the past, an eminent authority, Dr. Alan Gregg, in *The furtherance of medical research* (1941), has advocated that "the larger foundations return to making capital grants for endowment and for both the larger and the smaller foundations to make fewer grants for terms of seven to twelve years instead of one to three." In so far as these viewpoints are accepted by the foundations and point to a trend in their policy, it is to be hoped that aid from them to expand fundamental research in clinical medicine will be forthcoming, at least until the public feels obliged to assume the responsibility for the support of research and thus makes it possible for the scientist to devote himself to science and not to raising funds.

The responsibility for *initiating* significant expansion of basic research in clinical medicine and for formulating a program worthy of support from the foundations or the public rests primarily with those forward-looking clinicians and basic scientists who realize that continued progress in medicine depends upon the discovery of new basic principles.

Environment and Food Intake in Man

Robert E. Johnson[1] and Robert M. Kark

Harvard Fatigue Laboratory, Soldiers Field, Boston

ALTHOUGH IT HAS BEEN ASSUMED THAT feeding habits among men are modified by differences in climate (*4*), very few quantitative, reliable studies have been reported on the effects of different environments on the voluntary food intake of men doing the same type of work.

Between 1941 and 1946 reliable data have been collected on the average day's food which healthy, physically fit soldiers (ground troops) chose to eat from the rations provided in temperate, mountain, desert, jungle, arctic and subarctic areas in North America, Europe, and Asia. Most of these data were obtained during surveys and Army ration trials conducted intermittently throughout the war. Calculations were made according to the method of Berryman and Chatfield (*1*).

The present communication is taken from a critical review of the nutrition of United States and Canadian soldiers prepared in 1946 for the U. S. Army by Johnson and Kark (*3*). Fig. 1 and Table 1 show some data on the nutrient intake of healthy, physically fit, young North American soldiers who lived and fought in different environments in different parts of the world. Each point in Fig. 1 represents the average caloric intake for groups of from 50 to 200 men who, at the time of examination, were fully acclimatized to the particular environment in which they were living and who showed no signs of nutritional deficiency. For the purposes of this discussion, data have been selected only from groups of men who were receiving an ample ration in wide variety and of such quantity that they could have eaten more if they had wished to do so. This ideal situation in the feeding of troops was, unfortunately, not always achieved. The data show a striking correlation between the average voluntary daily caloric intake and the mean environmental temperature to which the groups of men were exposed. The range was

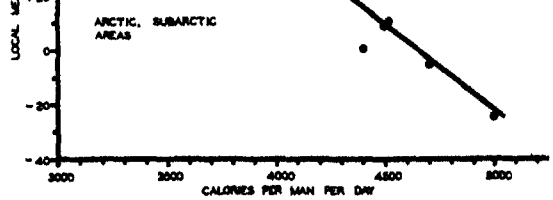

FIG. 1. Voluntary caloric intake, North American troops (averages for groups of 50 or more men).

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The subject matter of this paper has been undertaken in cooperation with the Committee on Food Research of the Quartermaster Food & Container Institute for the Armed Forces. The opinions or conclusions contained in this report are those of the authors. They are not to be construed as necessarily reflecting the views or endorsement of the War Department.

from 3,100 calories in the desert (92°F.) to 4,900 calories a day in the Arctic (−30°F.). This very large difference in caloric intake cannot be explained in terms of changing basal metabolic rates (*2*), which vary at the most by 20 per cent between arctic (Greenland) and tropical (Java) environments (equivalent to only 400 calories/24 hours); nor can it be explained in terms of difference in body size (Table 1) or in terms of different activities, since the ground troops carried out much the same tasks in all environments. We have no crucial evidence to decide this latter point, but we believe that the caloric expenditure for a given task is greater in cold than in warm climates because of the hobbling effect of arctic clothing and equipment. In addition, more heat is required in cold than in warm environments to maintain thermal equilibrium.

TABLE 1

Body Weight, Caloric Consumption, and Ratio of Protein, Fat, and Carbohydrate Eaten by Representative Groups of Ground Troops in Different Environments

Place and troops	Environment	Average body weight (kg.)	Average caloric intake/man/day	Percentage of calories provided by:		
				Protein	Fat	Carbohydrate
Canada, mobile force "Musk Ox"	Arctic and subarctic	73.0	4,400	11	40	49
U. S. A., ground troops	Temperate	69.0	3,800	13	43	44
Colorado Rockies, infantry	Temperate mountain (9,000 ft.)	69.5	3,900	13	34	53
Pacific Islands, ground troops	Tropics	70.0	3,400	13	33	54
Luzon, infantry	Tropics	65.5	3,200	12	34	54

Table 1 demonstrates that, regardless of environment, the percentage of proteins voluntarily chosen from the rations was practically constant in all environments, and that even in the tropics the percentage intake of protein and fat was "high" by traditional criteria and not much different from what it was in the Arctic.

The chief practical implications of these data are that the same general types of rations can be provided for ground troops regardless of environment, whether cold or hot, and that greater quantities of food are needed to feed men in cold weather than in hot.

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The Terminology of Pollination

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PLANT BREEDERS INTERESTED IN pollination work realize the variations relative to the application of the terms designating the expressions of pollination. It is not the purpose of this brief discussion to draw conclusions at the present time or to offer a cure for the ills which will be apparent, but simply to present facts.

The common conception of pollination in the angiosperms is the transfer of pollen from the anther to the stigma of a flower. There are, of course, exceptions to this general conception. For example, in horticultural usage alone, particularly with reference to orchard fruits, the term is sometimes applied in a general way to designate all the influences concerned in the setting of fruit; or pollination may be concerned with both the transfer of the pollen to the stigma and its subsequent germination thereon; while again, both pollination and fertilization have been used synonymously to imply application of pollen to the stigma. We are concerned with a brief presentation of the variability in use of the most common terms—self, close, and cross—used in delimiting the process of pollination, rather than with a discussion of the numerous terms which designate the ramifications of these general expressions and are based upon the great variety of structures and mechanisms among flowers.

Much confusion has been brought to the common conception of pollination as a transfer of pollen from anther to stigma, because structural, genetic, and mechanical aspects of the phenomenon have all been considered. This state of affairs pertains more to the common terms, such as self, close, cross, and closely applied terms which designate general types of pollination, than to specialized terminology as exemplified by the classifications of Knuth (*Handbook of flower pollination*, Vol. I, 1906). Horticulturists and botanists in general seem to differ as to the exact definitions of the terms self- and cross-pollination, usually defining them from a "mechanical" viewpoint, namely, a transfer of pollen. But in their *use* of the term the ideas of structure and genetics are brought in which extend this conception *beyond* the single act of transfer.

From one point of view, self-pollination is the transfer of pollen from the anther of a flower to the stigma of the same flower, and cross-pollination is pollination between the anthers and stigmas of different flowers on the same plant or between flowers on different plants of the same variety or different varieties. From another viewpoint, it would be considered that self-pollination is the transfer of pollen from one flower to the stigma of the same flower, to the stigma of another flower on the same tree, or to the stigma of a flower on another individual of the same variety. Likewise, in this sense, cross-pollination would involve the pollen of one variety and the pistil of another. Pollination within both monoecious and dioecious forms of the same variety or species would always be self-pollination, from one viewpoint; while dioecism would always be, and monoecism would sometimes be, cross-pollination in a typically different viewpoint. Only intraspecific pollination is reviewed here, since interspecific pollination is considered as cross-pollination in all cases.

Although these two general viewpoints are in evidence, the situation is confused by the continued appearance of definitions and usages of the terms self- and cross-pollination, which suggest different degrees of variation between the above two delineations. For example, self-pollination is the conveyance to the stigma of pollen from the anthers of the same flower or from a flower on the same plant, while cross-pollination involves pollen from a flower on another plant of the same or a different variety. Again, self-pollination is the transfer of pollen from the anther of a flower to the stigma of the same flower, while cross-pollination takes place between flowers of the same plant, or between flowers of different plants of the same variety.

Close-pollination has been frequently referred to in conjunction with self-pollination and, likewise, has also assumed different meanings. Whereas self-pollination is limited completely to an individual flower, close-pollination designates pollination involving different flowers on the same plant; yet again, exactly the reverse definition has been given. Close-pollination may also be extended by the same worker to mean pollination which takes place within an individual flower, between flowers on the same plant, or between flowers on the same plant and flowers on different plants of the same variety. Self- and close-pollination are also used synonymously in relation to the complete occurrence taking place within an individual flower. The term close-pollination has likewise been used to refer to the fact that in some plants pollination occurs before the buds open. Lastly, the term "self" may not be used at all, being replaced entirely by "close," which refers in such cases only to pollination between the anther and stigma of the same flower while cross-pollination refers to all other forms.

Open-pollination is used frequently in horticultural literature in a very broad sense to include uncontrolled pollination between anthers and stigmas, irrespective of their relations to each other—that is, whether they are in the same flower or in different flowers of the same or different variety. This term, therefore, is intended to be used in relation to artificial pollination as contrasted to natural pollination, and hence should not be included in the types discussed in preceding paragraphs. To do so would confuse the issue still more. Interpollination is used less frequently, and has been designated as pollination between closely related species or subspecies or between flowers of a cluster on the same plant.

In spite of the general confusion in terminology, the phenomenon could be considered from any of three viewpoints:

(1) Pollination defined in its original form as the transfer of pollen from an anther to a stigma would not necessitate the designation of the relative positions of anthers and stigmas. If it is considered in this manner, the single term *pollination* would adequately describe all types.

(2) The terminology could be enlarged to distinguish between the transfer from anther to stigma in the same flower and from the anther of one flower to the stigma of another, regardless of any hereditary relationship between flowers concerned. On this basis, the two terms *self-* and *cross-pollination*, respectively, would serve.

(3) However, we might take into account not only pollination within an individual flower and between different flowers, but also whether these different flowers are of the same clone, the same strain, the same variety, or the same subspecies or species. This would necessitate four major categories of pollination instead of one or two: (1) within an individual flower, (2) between flowers of the same plant, (3) between flowers of different plants of the same variety (where varieties are recognized) or species, and (4) between flowers which are on plants belonging to different varieties (either clonal or pure line) or species. In regard to (3), distinctions must be made between plants of (a) a variety whose population is made up of clones, such as the horticultural clones of pear, peach, apple, almond, and the like, and (b) a variety whose population is composed of sexually propagated individuals, such as many floricultural plants (aster, sweet pea).

Although it is known that inconsistencies do exist in the conception of what constitutes the different expressions of pollination, the extent of such inconsistencies is perhaps not fully realized. If we have done no more than present this situation and the facts in a more organized manner, this discussion has served its purpose.

NEWS
and Notes

The Association regrets to inform the readers of *Science* that on April 5, 1947, Dr. Willard L. Valentine, editor of the journal since January 1, 1946, died at his home from sudden heart failure.

Prior to assuming the editorship of *Science* Dr. Valentine was chairman of the Department of Psychology at Northwestern University. He is survived by his wife, Norma, and two children, Richard and Virginia. Funeral services were held in Columbus, Ohio, on April 8.

About People

Richard Foster Flint, professor of geology at Yale University, will present a series of three illustrated lectures on the general subject of "The Glacial Ages" at the Wagner Free Institute of Science, Washington, D. C. The lectures are entitled: "Glaciers of Today and Yesterday" (April 11), "Indirect Effects of Glaciation" (April 12), and "Glacial and Interglacial Climates" (April 18). The lectures will begin at 8:00 P.M., and admission will be free.

A. Earl Pritchard, U. S. Public Health Service Communicable Disease Center, has been appointed assistant professor of entomology and assistant entomologist in the Experiment Station, University of California, Berkeley.

James M. Schopf, paleobotanist, U. S. Bureau of Mines, has been granted leave to conduct a special study of South African coal under auspices of the South African Council of Scientific and Industrial Research, with headquarters at the South Africa Geological Survey, Pretoria. Dr. Schopf will return to this country early in October.

C. Stacy French, associate professor of plant physiology, University of Minnesota, Minneapolis, has been appointed director of the Division of Plant Biology, Carnegie Institution of Washington at Stanford University, California, to begin July 1. He will succeed H. A. Spoehr, chairman of the Division since 1932, who will devote full time to research on production of carbon compounds by plants.

Dr. French joined the Minnesota faculty in 1941. His research has been concerned with cellular respiration, the photosynthesis of purple bacteria and green leaves.

E. Raymond Hall, director, University of Kansas Museum of Natural History, returned March 20 from the University of Costa Rica Museum of Natural History after a month's study.

A. S. Pearse, professor of zoology, Duke University, was feted at dinner by over 60 biologists on his 70th birthday, March 14. He was presented with a bound volume of letters from former students.

Herbert M. Evans, director, Institute of Experimental Biology, University of California, delivered the 23rd Ludvig Hektoen Lecture of the Frank Billings Foundation, Institute of Medicine of Chicago, Friday evening, March 28. His subject was: "The Internal Secretions of the Pituitary Body."

Albert R. Mead, research fellow in zoology, University of California, Berkeley, has been appointed instructor in zoology, University of Arizona, Tucson.

Visitors to U. S.

Joel Axelsson, Institute for Utfodringslara, Uppsala, Sweden, is conducting research on the digestibility of feeds with Burch H. Schneider, Agricultural Experiment Station, West Virginia University, under a fellowship from Swift and Company, Chicago.

Maurice Stacey, University of Birmingham, England, will be guest of honor at sessions of the Division of Sugar Chemistry and Technology, American Chemical Society, at meetings in Atlantic City, April 15–17. On April 16 Prof. Stacey will participate in a symposium on sugars and amino sugars in biochemistry.

Gregory Wentzel, professor of theoretical physics, University of Zurich, is at present a visiting professor at Purdue University, Lafayette, Indiana.

A. J. Petrick, acting director, Fuel Research Institute, and **J. W. van der Merwe**, assistant industrial adviser, Department of Commerce, South African Government, arrived in this country early in March to study developments in synthetic liquid fuels production from coal.

Fellowships

Cornell University School of Nutrition announces the following fellowships for 1947–48: two Philco frozen food fellowships of $1,300, one for studies on cooking and another on processing frozen foods; and two $1,500 Robert Gould research fellowships in nutrition. Applicants must hold the Bachelor's degree and be otherwise qualified for admission to the School. Information may be obtained from the Office of the School of Nutrition, Cornell University, Ithaca, New York.

Grants and Awards

The 1947 Franklin Medal, highest honor of the Franklin Institute, Philadelphia, will be awarded to Enrico Fermi, Nuclear Research Institute, Chicago, and Sir Robert Robinson, professor of chemistry, Oxford University, England, at Medal Day exercises in Philadelphia April 16.

Dr. Fermi will receive the honor for outstanding work in the field of atomic energy. "His immediate recognition in 1932 of the neutron as an atomic projectile has resulted in much of what science knows today of this important development," the Institute stated. For this work he received the Nobel Prize in physics in 1938.

Sir Robert Robinson will be honored for contributions to the present knowledge of natural substances, particularly contributions in the sterol field and work on pyrimidine analogues and their relation to vitamin B. He was knighted in 1939 for contributions in the field of organic chemistry.

The gold medal, carrying a medallion of Benjamin Franklin, is awarded annually to workers, regardless of country or creed, who have done most to advance a knowledge of physical science and its application.

Charles Allen Thomas, vice-president and technical director, Monsanto Chemical Company, St. Louis, and president-elect of the American Chemical Society, was named as the second recipient of the Industrial Research Institute Medal at the close of the Institute's winter meeting in Chicago, February 27–28. Formal presentation of the award, which is granted for an outstanding contribution to industrial research, will be made at the annual meeting of the Institute in June.

Jacinto Steinhardt, formerly a physical chemist, National Bureau of Standards, has been awarded the President's Certificate of Merit by the Navy Department for "outstanding fidelity and meritorious conduct in aid of the war effort."

Dr. Steinhardt was cited for services as a member of the Anti-Submarine Welfare Operations, Research Group, a a group of scientists under OSRD, in devising original and effective tactics for aircraft in combating submarines and intercepting enemy blockade. He is now director of research of the successor organization, the Operations Evaluation Group, scientists and mathematicians engaged in scientific analysis of naval tactics, strategy, and new developments, furnished to the Office of the Chief of Naval Operations by Massachusetts Institute of Technology.

The Department of Obstetrics and Gynecology, University of Utah School of Medicine, was recently awarded the 1946 prize for outstanding clinical investigative work, presented by the Central Association of Obstetricians and Gynecologists. The work was described in a paper, "Menorrhagia Associated With Irregular Shedding of the Endometrium," presented by the authors, E. G. Holmstrom and C. E. McLennan, at a meeting of the Association in Chicago.

J. C. Geiger, director of public health, city and county of San Francisco, California, has been granted the Grand Ducal Order of the Oak Crown, House of Nassau, Grand Duchy of Luxembourg, founded as an Order of Merit in 1841. Dr. Geiger received the decoration through the foreign minister "for distinguished service to the Duchy of Luxembourg and its citizens and as a great humanitarian in the field of public health."

The Morris Liebmann Memorial Prize of the Institute of Radio Engineers has been awarded to Albert Rose, Radio Corporation of America Laboratories, Princeton, for 1946, and to J. R. Pierce, Bell Telephone Laboratories, New York, for 1947. Formal presentation was made at the Institute's annual dinner, Hotel Commodore, New York, March 5.

Dr. Rose, who has specialized in research in the field of television camera tubes, received the prize for work on the image orthicon picture tube, and Mr. Pierce, who has worked on high-frequency tubes, for his part in developing the traveling-wave type of tube.

Jerome P. Webster, Columbia-Presbyterian Medical Center, New York, was recently made a Commander of the Greek Order of the Phoenix for his work in restoring the features and limbs of Greek Army fliers wounded in the war. Presentation was made by John D. Kalergis, Greek Consul General, in New York.

E. Newton Harvey, Henry Fairfield Osborn professor of biology, Princeton University, has been awarded the grade of officer of the "Ordem Nacional do Cruzeiro do Sul" by the Brazilian Government, in appreciation of a series of lectures on biophysics delivered at the Instituto Biofisica in April 1946.

The Jane Coffin Childs Memorial Fund for Medical Research made the following appropriations on November 15, 1946, and February 21, 1947, a total of $202,616.66 in support of cancer research projects and fellowships:

F. Duran-Reynals, associate professor of bacteriology, Yale University School of Medicine, $49,500 for 3 years, 1947–50, for continued study of viruses and cancer.

J. Engelbreth-Holm, professor of pathology, University of Copenhagen, Denmark, $3,000, 1947, 1948, for continued study of the factors influencing carcinogenesis by chemicals.

W. U. Gardner, professor of anatomy, Yale University School of Medicine, $16,500, 1947–50, for continued investigations of the role of hormones in normal and abnormal growth.

Alexander Haddow, director, and his associates at the Chester Beatty Research Institute of the Royal Cancer Hospital (Free), London, England, $5,000, 1947–48, for continued support of the Institute's research program on chemical carcinogenesis, viruses and cancer, and chemotherapy of cancer.

J. G. Kidd, professor of pathology, Cornell University Medical College, $14,580, 1947–50, for continued study of viruses and cancer.

C. C. Little, director, and P. A. Gorer, guest investigator, Roscoe B. Jackson Memorial Laboratory, supplement of $1,000, 1946–47, to assist in Dr. Gorer's collaboration on investigations of immunological aspects of genetics.

C. P. Rhoads, director, and his associates at Memorial Hospital and Sloan-Kettering Institute for Cancer Research, $10,000, 1946–47, for continued chemical and metabolic studies of cancer with special reference to steroids.

W. T. Salter, professor of pharmacology, Yale University School of Medicine, $546.66 for 6 months, 1946, for biochemical studies of enzymes and steroids in relation to malignancy.

L. C. Strong, associate professor of anatomy, Yale University School of Medicine, $41,290, 1947–50, for continued genetical investigations of cancer.

J. C. Turner, assistant professor of medicine, Columbia University, College of Physicians and Surgeons, $8,000, 1947, 1948, for study of viruses and cancer.

Donner Foundation, for continued contribution to support of the journal, *Cancer Research*, $5,500 for 1947.

Yale University School of Medicine, supplement of $500, 1946–47, for replacement of equipment in animal house.

C. G. Baker, fellow, $1,800, 1947–48, to work with D. M. Greenberg, Division of Biochemistry, University of California, Berkeley.

J. B. Goetsch, fellow, $3,000, 1947–48, to work with C. L. Deming, Section of Urology, Department of Surgery, Yale University School of Medicine.

D. A. Karnofsky, fellow, $13,500, 1946–49, to work with C. P. Rhoads at Memorial Hospital and the Sloan-Kettering Institute for Cancer Research.

Joshua Lederberg, fellow, $2,400, 1947–48, to work with E. L. Tatum, Department of Botany, Yale University.

B. L. Newton, reappointed fellow, $3,500, 1947–48, to work with H. S. N. Greene, Departments of Surgery and

Pathology, Yale University School of Medicine.

Stanfield Rogers, fellow, $3,500, 1947–48, to work with Peyton Rous, Rockefeller Institute for Medical Research.

W. C. Schneider, fellow, supplement of $500, 1946–47, while working with Albert Claude, Rockefeller Institute for Medical Research.

J. E. Sokal, fellow, $9,000, 1947–50, to work with C. N. H. Long and H. S. N. Greene, Departments of Physiological Chemistry and Pathology, Yale University School of Medicine.

An allocation of $10,000 for 1947–48, to be used for expenses of conferences, lectures, consultants, and travel of investigators receiving grants from the Fund. A commitment of $4,500 has been made from this allocation to help bring foreign investigators to the United States for the Fourth International Cancer Research Congress in St. Louis, September 1947. A commitment of $3,000 has been made from a similar allocation for 1946–47 for the organizing and operating expenses of the Congress.

Colleges and Universities

The Harvard School of Public Health announces that Thomas M. Rivers, director of the Hospital of the Rockefeller Institute for Medical Research, will deliver the Cutter Lecture on Preventive Medicine in Amphitheatre D of the Harvard Medical School on April 22 at 5:00 P.M. Dr. Rivers' subject will be: "Certain Public Health Aspects of Infectious Diseases."

The Tulane University Council on Research has provided $12,350 for a five-year study of the reptiles and amphibians of Louisiana. The program, under Fred R. Cagle, associate professor of zoology, is designed to define species and accumulate data on reptile populations and histories. An expedition to western Louisiana and eastern Texas is planned for the summer of 1947.

Long Island University, Brooklyn, New York, has announced promotion of Curtis L. Weathers to professor and chairman of the Department of Biology, and Harold M. Messer to associate professor of biology.

The University of Hawaii opened its 40th anniversary celebration with a traditional island feast March 15. The following three college presidents were among U. S. speakers at the celebration: Karl T. Compton, Massachusetts Institute of Technology; Howard L. Bevis, Ohio State University; and Charles Seymour, Yale University. Gregg M. Sinclair, president of the University of Hawaii, extended invitations to these and other U S. participants.

Stanford University has announced the following appointments to begin in September 1947: Charles E. McLennan, professor and head of the Department of Obstetrics and Gynecology, University of Utah School of Medicine, has been named to the same position at the Stanford School of Medicine, San Francisco; Leonard I. Schiff, University of Pennsylvania physicist who worked on the Los Alamos project, associate professor of physics; and Josephine R. Hilgard, director of the Child Guidance Clinic, Children's Hospital, San Francisco, associate clinical professor of medicine.

The Ohio State University announces promotion of Julian B. Rotter to associate professor psychology and Abraham Edelmann to instructor of physiology.

Meetings

The South Carolina Academy of Science will hold its annual meeting in Columbia, South Carolina, on April 26 together with the Junior Academy of Science.

Over 30 papers have been scheduled for the Senior Academy meeting. Papers will be presented by those competing for the Jefferson Award, offered by Phipps and Bird, of Richmond, Virginia, for a paper based on original research.

A symposium on "Recent Advances in the Investigation of Venereal Diseases," to be held in the auditorium of the Federal Security Building, Washington, D. C., beginning at 9:30 A.M. on April 17, has been announced by J. E. Moore, chairman of the Syphilis Study Section of the National Institute of Health. Although it is not possible for the Study Section to defray travel expenses, all interested persons are invited to attend. Copies of the program will be sent upon request. All inquiries should be addressed to Dr. Gordon Seger, Executive Assistant, Syphilis Study Section, National Institute of Health, Bethesda 14, Maryland.

The Federation of American Societies for Experimental Biology announces that hotel rooms are still available for its May 18–22 meeting in Chicago. Requests should be addressed to Dr. F. J. Mullin, University of Chicago College of Medicine, Chicago 37, Illinois.

The Society of American Foresters will hold its annual meeting in Minneapolis, December 18–20, 1947, with headquarters in the Hotel Nicolett. E. L. Demmon, director of the Lake States Forest Experiment Station, St. Paul, is chairman of the program committee.

Elections

At a meeting of the **Branner Geological Society of Southern California,** California Institute of Technology, Pasadena, March 5, Vernon L. King, consulting petroleum geologist, was made president; Richard Jahns, California Institute of Technology, vice-president; and William H. Easton, University of Southern California, secretary-treasurer.

Emil Witschi, professor of zoology and experimental biology, State University of Iowa, has been elected a corresponding member of the Swiss Society of Genetics.

Recent Deaths

H. Van Gent, 47, head of the Johannesburg Observatory, died March 31 in Amsterdam. Dr. Van Gent's collection of astronomical photographs formed the basis for important investigations of the central structure of the Milky Way.

W. B. Scott, 89, professor emeritus of geology and paleontology at Princeton University, died March 29 in Princeton. Winner of the Wollaston medal of the Geological Society of London in 1910, Dr. Scott was an internationally known authority on fossil mammals.

R. S. Greene, 65, former general director of the China Medical Board of the

Rockefeller Foundation and vice-director of Peiping Union Medical College since 1929, died March 27 in West Palm Beach.

Juan Noé, 70, director of the Instituto de Biología of the Universidad de Chile, died January 22 in Santiago. In addition to serving on the faculty of the University for 35 years, Dr. Noé was instrumental in the sanitation of large malaria areas in northern Chile and was in large part responsible for the founding of the Institute.

A letter has been received from Abdul Majid, president of the University of Kabul, Afghanistan, asking support of American bacteriologists in rebuilding the reprint collection of his university. Sanford Elberg, Department of Bacteriology, University of California, Berkeley, who received the letter, said the Afghanistan institution has received nothing in bacteriological literature since 1940 and is especially in need of material on microbiology and public health.

The Committee for the Study of Animal Societies Under Natural Conditions held its first meeting in New York, January 31 and February 1, under auspices of the New York Zoological Society, following arrangements made at the Conference on Genetics and Social Behavior, Roscoe B. Jackson Memorial Laboratory, last summer.

At the New York meeting J. P. Scott was elected executive secretary to coordinate activities of the Committee. The following were made chairmen of subcommittees on special research projects: C. R. Carpenter, Jackson Hole Research Project; T. C. Schneirla, subcommittee to survey locations and institutions in which research on animal social behavior and organization is possible; and Fairfield Osborn, ways and means.

Purpose of the conference was to help organize a research program on animal behavior, particularly in connection with the New York Zoological Society's new station at Jackson Hole, Wyoming. Action was also taken on the Barro Colorado Island Biological Station, which, the Committee believes, needs to be put on a permanent basis of support as a center of tropical research.

The secretary's office, it is hoped, will be a clearinghouse for research ideas and projects of various individuals and institutions. Correspondence should be addressed to J. P. Scott, Roscoe B. Jackson Memorial Laboratory, Bar Harbor, Maine.

Research on the fundamental principles of phosphate fixation and release by soils, utilizing radioactive phosphorus, will be conducted by the North Carolina Agricultural Experiment Station, Raleigh, under a grant from the Phosphate Research Committee of the fertilizer industry. The Experiment Station has arranged for cooperation with the New York Agricultural Experiment Station, Ithaca, and Bureau of Plant Industry, Soils, and Agricultural Engineering, USDA, Beltsville, Maryland.

The technical committee, representing industry, consists of H. B. Siems, Swift & Company; R. R. Hull, I. P. Thomas and Sons Company; H. E. Hendricks, Knoxville Fertilizer Company; F. E. Boyd, Virginia Carolina Chemical Corporation; and V. Sauchelli, Davison Chemical Corporation, chairman.

The American Society of Professional Biologists has intensified its organizational activities due to response to the article, "A Society for All Biologists," which appeared in *Science*, October 4, 1946. Copies of the proposed constitution and applications for membership may be obtained from Roy F. Fritz, 605 Volunteer Building, Atlanta, Georgia, or Norman C. Laffer, Department of Bacteriology, University of Maryland, College Park, Maryland.

A Swedish zoological expedition of six members, headed by Åke Holm and Bergt Lundholm, Upsala University, will investigate the fauna on Kilimandjaro and a number of other East African peaks, on which various animal species from earlier and more humid epochs have survived. The expedition is expected to leave Sweden in the fall and spend about a year in Africa.

The first natural history museum in Iraq was established in Baghdad early in 1946 and is now operating under the auspices of the Iraq Ministry of Education.

According to Bashir E. Allouse, director, and member of the AAAS, the Iraq Natural History Museum consists of three main sections: Zoological Section, with exhibits of the avifauna of Iraq and small collections of Iraq mammals, reptiles, fishes, and invertebrates; Botanical Section, with plaster-made models of Iraqi fruits and vegetables and specimens of plant products, economic plants, and plant diseases; and Geological Section, with a cement model of the geological structure of Kirkuk oil fields, presented by Iraq Petroleum Company, and a model of an oil refinery, oil products, and other items, presented by the Rafidain Oil Company, as well as specimens of rocks, crude oil, and fossils found in Iraq.

The museum seeks contacts with similar museums in the U. S. and other countries with a view to exchanging information and publications. Contributions of books, periodicals, and bulletins should be sent to the Director, Iraq Natural History Museum, Baghdad, Iraq.

An International Trust for Zoological Nomenclature has been established for the purpose of managing the financial, commercial, and other business affairs of the International Commission on Zoological Nomenclature, according to Francis Hemming, secretary of the International Commission, who writes:

"In view of rapid growth in recent years in the volume of its work, the International Commission on Zoological Nomenclature, an unincorporated body of 18 international commissioners elected by the International Zoological Congress, recently formed an incorporated body under United Kingdom law with the title, International Trust for Zoological Nomenclature. At the same time the International Commission has transferred its assets to the International Trust and the Trust has accepted responsibility for all liabilities of the Commission.

"Under the new arrangements, the Commission will continue all its scientific functions while the Trust will be responsible for publishing the Commission's *Opinions* and other publications, meeting its administrative expenses, and carrying out such further developments as may be decided on by the Commission.

"Members of the Commission will be members of the Trust and the secretary to the Commission will be secretary *ex-officio* to the Trust. The Trust has taken over as its registered office 41, Queens Gate, London, S.W.7., hitherto occupied by the Commission. The Commission has arranged for appointment of certain honorary unpaid officials of the Commission as members of the Trust to ensure that there will at all times be a sufficient number of members available to attend meetings of the Trust. At invitation of the Commission chairmanship of the Trust has been accepted by Col. the Rt. Hon. Walter Elliot."

Full text of the instrument of incorporation will be published in an early issue of the Commission's *Bulletin of Zoological Nomenclature*.

The foundation stone was laid November 21, 1946, for an $11,000,000 National Metallurgical Laboratory at Jamshedpur, India, part of a program of the Indian Council of Scientific and Industrial Research and the Government of India to establish a chain of 7 research laboratories in different parts of the country.

According to G. P. Contractor, Research Laboratories, The Tata Iron & Steel Company, Ltd., Jamshedpur, the laboratory will cover both fundamental and applied metallurgical research. A descriptive note from Dr. Contractor states: "Provision has been made in final plans of the National Metallurgical Laboratory for administration, including statistics, library, museum; chemical analysis, physical chemistry, physics as it affects metallurgical problems; examination, preparation, and smelting of metallic ores; melting, heat treatment, and working of metals and alloys; research into the structure and physical properties of metals and alloys; electrodeposition and surface treatment of metals; and research on refractories."

The laboratory will consist of a main building and separate technological block. The main building, containing offices, laboratory, museum, theater, and library, will have three floors with a total of 60,600 square feet of working area. The technological block, with large workshop laboratories and associated control rooms, will provide working floor area of about 28,000 square feet.

Early in January cornerstones were laid for the new National Physics Laboratory, modeled on our National Bureau of Standards, and for a Laboratory of Industrial Research, both in Delhi. The Central Glass and Ceramic Research Institute in Calcutta and the Fuel Research Institute, Dhanbad, in addition to the National Metallurgical Laboratory, were founded during 1946.

Harlow Shapley, director, Harvard College Observatory, and president, AAAS, who was a guest of the All-India Science Congress in Delhi during January, observed Pandit Jawaharlal Nehru, leader of the Congress Party, accept presidency to the newly-created Association of Scientific Workers of India, to be assembled from the faculties of the 20 universities in India and from the technical workers in the textile, steel, jute, and other factories.

The food research and development program of the Quartermaster Corps, Chicago, has expanded 50 per cent since V-J Day and now has a staff of 250, occupies 120,000 square feet of floor space, has an equipment inventory of $500,000, and an annual operating budget of approximately $2,000,000.

The Institute is a coordinating center, working with more than 500 industrial laboratories on food, ration, and container development problems, and with more than 80 colleges, universities, and other research institutions on fundamental problems in food research. Results of this effort are more than 300 food and ration specifications, basis of the food procurement program for the armed forces. From a technological standpoint, the Institute is operated almost entirely by civilian scientists and technologists.

According to a letter received from Guido Grandi, director of the Instituto di Entomologia della Università, Bologna, the Institute was destroyed by the Anglo-American bombardment, but by repeated removals during three years, partly preceding and partly following the bombardment, all of the library, collections, and apparatus were saved. The letter, received by J. C. Bradley, professor of entomology, New York State College of Agriculture, Cornell University, states that the Institute is now in reconstruction and has fully resumed its activities. Publication of the *Bolletino* has been continued, and the 15th volume will shortly be issued.

The Societa Entomologica Italiana was seriously and irreparably damaged, according to the letter, the bombardment having destroyed 50,000 volumes, though the *Bolletino* and *Memorie* are being continued in reduced scale.

Hui-Ling Li, professor of botany, Soochow University, and former member of the AAAS, is attempting to rebuild his botanical library following return to China in 1946, after six years work in this country. He would appreciate receiving reprints of papers from American botanists. They may be addressed to: Dr. Hui-Ling Li, Department of Biology, Soochow University, Soochow, China.

The National Registry of Rare Chemicals, Armour Research Foundation, 35 West 33rd Street, Chicago 16, Illinois, has submitted the following list of wanted chemicals: 1,18-octadecandioic acid; nucleoproteins; millite; gahnite; celsian; prismatin; sapphiran; tetrophan; 4-amino-2,2′-dichlorobenzophenone; 4-amino-2,4′-dichlorobenzophenone; eicosenol-1; talomucic acid; agaric acid; d-fucose; elaidic acid; pyrroline; tropic acid; d-quercitol; glucurone; and hydrindene.

The 20th Josiah Willard Gibbs Lecture was delivered by Subrahmanyan Chandrasekhar, of the Yerkes Observatory, University of Chicago, before the 53rd annual meeting of the American Mathematical Society, Swarthmore College, Swarthmore, Pennsylvania, in December. Dr. Chandrasekhar's subject was "The Transfer of Radiation in Stellar Atmospheres." By invitation, addresses were also given by A. P. Morse, University of California, on "Derivatives and Their Integrals," and Harald Cramér, University of Stockholm, on "Some Aspects of the Theory of Stochastic Processes." Seventy research papers were presented at the meeting, attended by over 500 people.

Make Plans for—

American Chemical Society, spring meeting, April 14–18, Atlantic City, New Jersey.

Association of Southeastern Biologists, 8th annual meeting, April 18–19, Emory University, Georgia.

Southeastern Section, Botanical Society of America, Inc., 4th annual meeting, April 18–19, Emory University, Georgia.

Institute of Mathematical Statistics, meeting on stochastic processes and noise, April 24–25, New York City.

American Geophysical Union, 28th annual meeting, April 28–30, National Museum, Washington, D. C.

COMMENTS *by Readers*

Please! New York's city colleges have had a difficult enough time telling the American public of the good work they have done these many years. Your note on page 159 of the February 7 issue of *Science* on the death of Morris Raphael Cohen, identifying him as "professor of philosophy at the University of Chicago until his retirement in 1941," robs the City College of the most sparkling jewel in its diadem of scholars. It is true that Prof. Cohen taught one or two quarters at Chicago, but before that and for much of his productive life as mathematician, philosopher, writer, scholar, and teacher, from about 1912 to his retirement, he was a member of the Department of Philosophy, City College of New York.

In all the four New York city colleges, we were proud for many, many years to count ourselves as colleagues of Prof. Cohen, and it comes as something of a shock to us to find him identified simply with the institution at which he temporarily taught for a short interval after his retirement from the City College. (AUSTIN B. WOOD, ***Brooklyn College, Brooklyn, New York.***)

* * *

Our interest in the fauna of Joshua Tree National Monument, on the Southern California desert, has taken A. J. Van Rossem and myself to the area on three occasions during the past winter (1946–47). The monument is confined to the "high desert" terrain of San Bernardino and Riverside Counties, the stations which we occupied ranging from 3,500 to 4,700 feet above sea level. Furthermore, this winter seems to have been slightly below average in temperatures. Observations were made during the first weeks of November, of December, and of February.

Daytime temperatures in direct sunlight were cool enough to make it uncomfortable to remain inactive without warm clothing. As soon as the sun dropped behind the San Gorgonio Mountain mass to the west, the air rapidly became cold. At 7:00 P.M. the temperatures would fall to 33°–38° F. At sunrise the temperatures would range between 20° and 28°. In short, the temperatures were winter temperatures for the area, and night temperatures remained low throughout the whole period of darkness.

During each visit to the monument, bats were seen or heard in active flight in air strata from head height to distances 40–50 feet above the ground. Small Lepidoptera occasionally came into the light of our campfire, and desert mosquitoes visited our sleeping bags though ice formed in our drinking water.

Once at dawn the bats came close enough to my head to give the impression of a small species—probably a *Pipistrellus*. On one occasion at 11:15 A.M. in bright, clear sunshine, a small, gray-brown bat with dark membranes came to the cattle trough at Quail Spring and dipped the surface of the water after the fashion of drinking swallows. The temperature four hours earlier had stood at 20° F.

The following conclusions seem justified: (1) The bats seen or heard were not in transit; (2) they remained active during a considerable portion of the night; (3) such activity could hardly be that of a hibernating animal temporarily aroused by warm periods of weather; (4) some insect food species are active at surprisingly low temperatures; (5) some species of bats have temperature tolerance of fairly wide range. (LOYE MILLER, *University of California at Los Angeles.*)

* * *

Some time ago the undersigned published a note, in the Dutch language, on the action of neutrons on hafnium, no other way of publication being available at the time (*Ned. Tijdschr. Nat.*, 1943, 10, 258). As this paper is hardly accessible, it seems worth while to mention its contents here. With slow neutrons a period of 20 seconds was reported; with fast neutrons periods of 20 seconds, 10 minutes, and about 6 hours. As the stable hafnium isotopes are 174, 176, 177, 178, 179, and 180, the second period was supposed to be due to Hf^{175}, and it was recommended for the estimation of hafnium in mixtures with zirconium. It was also shown that zirconium could be determined in mixtures with hafnium by prolonged irradiation with fast neutrons. Under these circumstances no periods of the order of days were found in hafnium; after two days decay the activity of our hafnium sample amounted to only 2 per cent of that of a similarly treated zirconium sample.

Recently, A. Flammersfeld (*Z. Naturforsch.*, 1946, 1, 190) also has observed the formation of a hafnium isotope with slow neutrons. Since he used (D + D) neutrons instead of (Li + D) neutrons, as we did, he has not been able to observe the formation by the (n; 2n) process. He was, however, able to carry out some absorption measurements of the radiation, which lead to the assumption that the 20-second isotope is an isomer, decaying with internal conversion. Of the mass numbers suggested by his experiments (175, 177, 178, 179, 180, and 181), this author rules out the first and the last by means of intensity considerations and the numbers 178 and 180 on the strength of a rule of Mattauch. Mass numbers 180 and 181 are definitely excluded by the activation with fast neutrons. (A. H. W. ATEN, JR., *Natuurkundig Laboratorium der N. V. Philips' Gloeilampenfabrieken, Eindhoven, Holland.*)

* * *

A new laboratory plant for the study of carbohydrate metabolism is recommended by John S. Bailey and Emmett Bennett, of Massachusetts Agricultural Experiment Station, Amherst, Massachusetts. The plant, ***Impatiens Sultanii***, is a commonly used household ornament growing to the height of 12–24 inches. Exudates proved to be principally sucrose. The stems on a dry weight basis yield approximately 33 per cent reducing sugars as dextrose. Nonreducing sugars are present only in traces. Although the amount of sugar is only one-third to one-half that found in sugar beets or sugar cane, it is high compared with most other plants.

TECHNICAL PAPERS

The Effect of Body Temperature on the Duration of Barbiturate Anesthesia in Mice

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Both toxicity and duration of action of many central nervous system depressants are influenced by temperature. Most investigators have dealt chiefly with the influence of environmental temperature on the toxicity of these drugs (*4*). The few available investigations which have considered the influence of temperature on the duration of action have failed to specify the changes in body temperature resulting from exposure of the animals to varied environmental temperatures. The body temperatures of small animals at extremes of environmental temperature are well known to be unstable even without anesthesia. It is apparent that for the anesthetized animal the determination of environmental temperature alone is inadequate.

Cameron (*2*) and Gaylord and Hodge (*5*), using pentobarbital in rats, and Raventos (*7*), using evipal in mice, found the duration of sleep with a given dose of the barbiturate to increase with decrease in environmental temperature. Although body temperatures were not reported, it seems certain that marked changes must have occurred at the environmental temperatures employed.

In order to determine the influence of body temperature on the duration of action of some barbituric acid derivatives, the experiments summarized in Table 1 were carried out. Albino mice of both sexes were used, and the experiments with a given drug were performed simultaneously at two temperatures. To obviate differences in rate of absorption due to temperature, the animals were all injected at room temperature, which was maintained until anesthetization. Half of the group were then transferred to a chamber maintained at 35–37° C., and the other half were rapidly cooled to a body temperature of 25–27° C. by contact with a metal plate at approximately 0° C. The two groups were then maintained at *body* temperatures of about 37° C. and 27° C., respectively, by varying the rate of heat loss through warming or cooling. Body temperatures were determined in each mouse in rotation, using two potentiometers and iron-constantan thermocouples inserted rectally to a depth of 15 mm. Sleeping time was taken as the interval between loss and recovery of the righting reflex.

Table 1 shows that the duration of action of pentobarbital and Sandoptal[1] is greatly prolonged by a reduction in body temperature of 10° C., while that of barbital is scarcely affected by such a reduction in temperature. The chief difference between barbital and the other two derivatives studied lies in their fate in the body. Barbital (diethylbarbituric acid) is relatively stable and is readily excreted in the urine; its action is prolonged by bilateral nephrectomy but not by hepatic damage or by subtotal hepatectomy. Pentobarbital (ethyl-1-methylbutyl-barbituric acid) and Sandoptal (allyl isobutyl barbituric acid), on the other hand, are excreted in the urine only in traces; their anesthetic action is prolonged by liver damage or by hepatectomy but not by bilateral nephrectomy. Therefore, barbital is detoxified chiefly by urinary excretion, while pentobarbital and Sandoptal are detoxified by inactivation in the tissues, of which the liver probably is the most important. Sandoptal was included here because it is intermediate in duration of action but is readily inactivated by the tissues. Although the mechanism of tissue inactivation of pentobarbital, Sandoptal, and other short-acting barbiturates is not understood, it seems probable that it is enzymic in nature and that, in common with other enzymic processes, it is slowed by a reduction in temperature. Masson and Beland (*6*) have classified the barbiturates on the basis of the mechanism of detoxification (tissue inactivation or elimination by the kidney, or both). In general it is to be expected that the duration of action of those barbiturates which are inactivated in the tissues will be prolonged by a reduction in body temperature, while that of derivatives excreted by the kidney will be little affected by changes in body temperature, except for a possible

TABLE 1

DURATION OF BARBITURATE ANESTHESIA IN MICE AT TWO LEVELS OF BODY TEMPERATURE*

	Barbital	Pento-barbital	San-doptal
Dose (Na salt) (mg./kg.)	290	37.5	55
Body temperature, 37°C.:			
No. of animals	12	11	9
Mean body weight (grams)	22.4	20.1	20.5
Mean sleeping time (min.)	314.5	17.6	76.9
Standard Error	20.02	3.33	12.21
Body temperature, 27°C.:			
No. of animals	11	11	7
Mean body weight (grams)	22.4	21.5	23.3
Mean sleeping time (min.)	331.5	61.8	202.7
Standard Error	22.14	4.51	20.08
P†	0.1	<0.001	<0.001
Ratio, $\frac{\text{Sleeping time, 27°C.}}{\text{Sleeping time, 37°C.}}$	1.05	3.5	2.6

* All barbiturates were administered intraperitoneally as the sodium salt in solutions of such strength that the dose was contained in 0.1–0.3 ml.

† P expresses the probability that the difference between the sleeping times at the two body temperatures would occur through errors in random sampling; see Fisher (*3*) for method of calculation.

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[1] The Sandoptal was kindly supplied by Mr. Harry Althouse, Sandoz Chemical Works, West Coast Branch, San Francisco.

effect of this temperature on the rate of their excretion in the urine.

Many years ago Brunton (*1*) found that warming reduced the incidence of death in animals poisoned with chloral hydrate, a depressant which is largely detoxified by conjugation in the liver, and recommended that victims of acute chloral poisoning be kept warm. The data presented here also provide a rational basis for the application of warmth in cases of acute barbiturate poisoning involving short-acting barbiturates which are inactivated by the tissues.

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Hyperheparinemia: Cause of the Hemorrhagic Syndrome Associated With Total Body Exposure to Ionizing Radiation[1]

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Hemorrhage is one of the most striking features of the syndrome which follows acute whole-body exposure to ionizing radiations in the midlethal range. This irradiation-induced bleeding phenomenon occurs in man as well as in many experimental animals. In our experience the dog proved more suitable for study than the rabbit, guinea pig, rat, mouse, or goat, and the picture displayed by the dog later proved to be very similar to that seen in man following the bombing of Hiroshima and Nagasaki (*3*).

The hemorrhagic disease of irradiation is accompanied by a thrombocytopenia. Both bleeding and clotting times are prolonged, and clot retraction is impaired. At death, both animal and man show extensive hemorrhages which may occur in all organs of the body but which are first seen in the organs of motions, such as the intestines, heart, lungs, skeletal musculature, and urinary bladder.

This disease has been thought to result from the associated thrombocytopenia (*2*). However, in a study carried out on dogs during the past three years we have concluded that the thrombocytopenia plays only a secondary role in producing hemorrhage (*1*). Of greatest significance in this disease is the presence in the blood of an increased amount of free heparin. These conclusions are based on the following observations:

(1) The clotting time in both man and dog may be greatly prolonged or the blood rendered entirely incoagulable after acute exposure to ionizing radiations such as X-rays delivered over the entire body. If the clotting time is sufficiently prolonged, the blood of an irradiated dog will delay the clotting time of normal blood, thus demonstrating the presence of an active anticoagulant not normally present in blood.

(2) Evidence that this anticoagulant is heparin is based on the fact that specific antiheparin substances, such as toluidine blue and other members of the thionine series, and protamine will return the clotting time to normal both *in vivo* and *in vitro*. These substances will prevent or stop hemorrhage even though the platelet count may be less than 50,000. The effect of toluidine blue on the *in vitro* clotting time of an irradiated dog is shown in Fig. 1. It will be noted that the dye is both coagulant and anticoagulant, and that its effective antiheparin range gives way to its anticoagulant property as the concentration of the dye increases. The clotting time of the blood of this animal was greater than 48 hours, but after the intravenous injection of 24 mg. of toluidine blue the clotting time returned to normal within 20 minutes after dye administration.

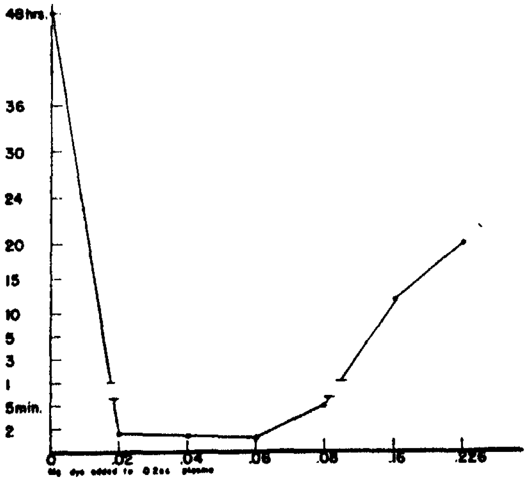

Fig. 1. The antiheparin and the anticoagulant effect of toluidine blue on the clotting time of plasma in an irradiated dog (Dog 108).

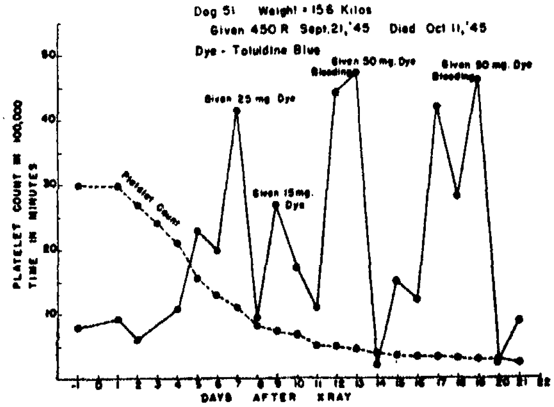

Fig. 2. The effect of repeated injections of toluidine blue on the whole-blood clotting time of an irradiated dog.

(3) An anticoagulant which was indistinguishable from heparin, was isolated from the blood of irradiated dogs, and on the basis of the number of units of potency per milligram of

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[1] This paper is based on work performed under Contract No. W-7401-eng-37 with the Manhattan Project for the University of Chicago. It will appear in Volume 22B of the *Manhattan Project Technical Series* as a part of the contribution from the University of Chicago Project.

weight the isolated material proved to be as active as our standard (Abbott) sodium acid salt of heparin. Our material was inactivated by both toluidine blue and protamine and was heat stable.

(4) Thrombocytopenia *per se* did not appear to play an important role in the development of hemorrhage because, while hemorrhage and thrombocytopenia always occurred in the same animal, the time of onset of each varied considerably and did not always coincide (Fig. 2). Moreover, when the dye was given, bleeding was controlled, but the platelet count, if reduced, was not raised.

(5) The administration of vitamin K, ascorbic acid, calcium salts, and fresh whole blood transfusions did not prevent the onset of hemorrhage or stop bleeding once it occurred.

These observations have led us to study the effect of toluidine blue on the course of the hemorrhagic manifestations associated with such diseases as ideopathic thrombocytopenia and acute leukemias. The preliminary results indicate that significant temporary alleviations of the hemorrhagic manifestations may be thus induced.

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Treatment of Plutonium Poisoning by Metal Displacement[1]

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The great increase in availability and use of radioactive elements since the advent of the chain-reacting pile has intensified the need for effective treatment of radioelement poisoning. Radium poisoning has been a recognized danger since 1925. At present we are concerned primarily with plutonium (Pu^{239}), which emits 140,000,000 alpha particles/mg./minute and has a half-life of about 24,000 years. Many of the long-lived radioelements, including plutonium, which find their way into the body are deposited mainly in the skeleton. An appreciable amount of plutonium is also found in the liver and spleen. The dangers of plutonium far exceed those of radium poisoning because of the relatively large quantities of plutonium available and because of the number of individuals exposed.

From a consideration of ion exchange principles it may be predicted that the excretion of plutonium from "plutonized" animals would be increased by treatment with large amounts of the soluble salts of certain metals. The metals considered were those possessing a high valence and a metabolism similar to plutonium, so that their concentration relative to plutonium in a given site could be preponderant. An ideal metal would combine maximum displacing properties with minimum toxicity. The treatment, called metal displacement therapy, utilizes an innocuous metal, zirconium, to hasten the removal of plutonium from the body. Although this is still in very early and preliminary experimental stages, the results obtained so far are encouraging.

TABLE 1

Effect of Zirconium and Sodium Citrate Treatment on the Urinary Excretion of Plutonium in Rats*

(Data expressed as average per cent of injected dose of plutonium excreted each day)

Days elapsed following Pu injection	Pu control	Treatment			
		Zirconium (100 mg. on 2nd hr. and 3rd day after Pu injection)	Zirconium (50 mg. on 2nd and 24th hr. after Pu injection)	Sodium citrate (4 ml. of 10% sol. on 2nd hr. and 3rd day after Pu injection)	Sodium citrate (2 ml. of 10% solution on 2nd and 24th hr. after Pu injection)
0–1	0.75	8.2	5.1	3.2	3.1
1–2	.051	.12	.66	.07	.68
2–3	.027	.032	.060	.037	.041
3–4	.041	.60	.078	.19	.041
4–5	.045	.022	.060	.016	.023
5–7	.022	.07	.058	.011	.018
7–10	.021	.064	.083	.020	.017
10–12	.024	.060	.059	.021	.010
12–14	.016	.064	.053	.026	.022
Total Pu excreted in urine for 14-day period.......	1.1	9.6	6.5	3.7	4.0

* The rats (200-gram females) received 1.1 mg. of Pu/kg.

From a series of preliminary experiments dealing with the excretion of plutonium by rats after intravenous injections of aqueous solutions of lanthanum, cerium, and zirconium salts, it was concluded that, of those tested, zirconium was the most promising metal on which to concentrate effort.

The injection solution used contained from 20 to 25 mg. of zirconium dissolved in 10 per cent sodium citrate.

Young adult (200 grams) albino female rats and a young mongrel dog were used. The time at which zirconium treatment was begun, following the intravenous injections of plutonium, varied from two hours to five months, in the case of the dog. The rats received intraperitoneal and the dog intravenous injections of the zirconium citrate solution.

The effect of zirconium treatment on the urinary excretion of plutonium is shown in Table 1. The administration of zirconium in those rats treated shortly after the injection of plutonium was followed by as much as a 15-fold increase in the amount of plutonium excreted in the urine over a 24-hour period. When the output of plutonium had dropped, a reinjection of zirconium was followed by a second rise in the elimination rate. Actually, the reinjected rats excreted nearly as much plutonium on the fourth day following plutonium administration as the control rats eliminated during the first 24 hours. Finally, the sustained therapeutic action was shown by the observation that the excretion

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[1] This report is based on work begun early in 1945 and performed under Manhattan District Contract No. W-31-109-eng-38 at the Metallurgical Laboratory of the University of Chicago and the Argonne National Laboratory, Chicago.

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The writer wishes to express his appreciation for the cooperation and technical assistance of members of the Medical and Biology Divisions, Argonne National Laboratory.

level remained about three times greater than that of the controls for several days after the cessation of zirconium therapy.

A small part of the heightened excretion was due to the sodium citrate solvent. However, the amount of plutonium eliminated by the animals treated with sodium citrate alone fell abruptly to pretreatment levels after the sodium citrate injections were discontinued.

None of the treatments significantly altered the quantity of plutonium excreted in the feces.

Tissue analyses revealed that the zirconium-treated rats had only about half as much plutonium in the skeleton and in the liver as the control animals, but the concentration of plutonium in the muscle and kidneys of these animals was greater than that found in the controls. The bone and liver concentrations of plutonium in the rats treated with sodium citrate did not seem to differ appreciably from those in the controls.

Five months after the dog received an intravenous injection of 0.058 mg. of plutonium/kg. treatment with very small doses of zirconium citrate (4–16 mg./kg. of body weight), injected intravenously, was begun. A very definite increase in urinary excretion of plutonium occurred within the first few days following each dose of zirconium. The extent of the rise in the elimination rate in the urine was directly proportional to the amount of zirconium injected. The increased rate of excretion was continued for at least three weeks after the cessation of zirconium treatment. Even with these dosage levels, which were far below the maximal dose by a factor of at least 10, the elimination rate of urinary plutonium was increased more than 150 per cent over the pretreatment level.

The average excretion of plutonium in the feces of the dog, following the zirconium treatment, appeared to increase but slightly.

In rats treated with zirconium about five weeks after the injection of plutonium, a roughly 10-fold increase in the urinary excretion of plutonium was observed. These animals were sacrificed shortly after treatment and were found to have only half as much plutonium in the liver as the controls. The bone content of plutonium was unchanged.

It appears, therefore, that zirconium first acts to displace plutonium from the liver. Later it migrates to the bone and slowly but continuously displaces the deposited plutonium to an extent which depends on the concentration of zirconium relative to the plutonium.

Radioautograph studies (*1*) have shown that plutonium, cerium, yttrium, and zirconium are laid down in the uncalcified organic matrix of the bone and in the endosteum and periosteum. Strontium, on the other hand, is deposited almost exclusively in bone salt, and it might be expected that zirconium treatment would have little effect in cases of radiostrontium poisoning. This was shown experimentally where it was found that zirconium treatment had only a negligible effect on the excretion rate of radiostrontium and on its concentration in the liver and bone of rats. Experiments to test the effect of zirconium treatment in cases of radioyttrium poisoning are in progress.

A study of the toxicity of zirconium and other metals revealed that zirconium was by far the safest for therapeutic use. When zirconium was given in single massive doses of 1.5, 1.75, and 2.0 grams/kg. of body weight, the percentages surviving were 100, 50, and 0, respectively. No harmful chronic effects have as yet been found.

Within 24 hours after the injection of zirconium, 80–90 per cent of the metal was excreted in the urine. Its fecal excretion is, however, very low.

The action of sodium citrate in promoting the excretion of plutonium can be attributed to its ability to increase the diffusibility of plutonium (*2*) and thus facilitate its clearance through the kidney.

Further investigations of metal displacement therapy in cases of chronic poisoning by plutonium and other long-lived radioelements are in progress.

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Effect of Temperature on the Growth and Sterility of Maize

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Varieties of corn grown in the Northeast and in the Middlewest at the same latitude are noticeably taller in the East. Several environmental conditions, principally light intensity and temperature, are involved in this growth difference. Plants of many species, including maize, grown under tobacco shade cloth are significantly taller and broader in leaf than plants from the same lot of seed grown in full sunlight. Under the cloth shade the temperature is the same as outside, but the humidity is higher and the light intensity is lower. The same effect is noticed in the field, where short-stalked varieties of corn are grown in single rows between taller varieties. Where there is a wide alley between ranges, the plants at the ends of the rows are shorter than those in the center of the rows, the plants graduating in height. Here humidity and temperature are the same, but light intensity varies.

Some corn seedlings started in the greenhouse and set outdoors were shorter at maturity than plants from the same seed started outdoors. This indicated that temperature in the early stages of growth had an effect. To test this, seeds of a uniform, vigorous, first-generation hybrid (WF_9 × P8) were germinated in an incubator at about 30° C. until the shoots and roots were from ¼ to ½ inch long. Three different lots of these sprouted seedlings were held at 40, 50, and 60° C. for one hour, after which they were planted in pots and left in the greenhouse until it was certain the plants would grow. They were then set in the field alongside plants from the same lot of seed sown in the open ground at the same time the treated seedlings were started in the incubator. Some of the heat-treated seedlings died, but enough were started in each lot and later thinned to give an even stand of plants in the field.

All three lots of heat-treated seedlings were shorter in height, less vigorous in growth throughout the season, and later in flowering than the untreated plants. All lots grew to full maturity and were measured after growth had ceased. The results in inches of height were: control, 101; 40° C., 87; 50° C., 89; and 60° C., 93, *i.e.* an average of 90 inches in height for the heat-treated lots compared to 101 inches for the control.

An unanticipated result was the pollen sterility in all treated lots. Normal tassels were produced with well-developed florets, but the anthers were small and shriveled and for the most part remained enclosed in the glumes. In view of the fact that high temperatures sterilize the male germ cells in animals from amphibians to mammals, these results are highly significant. This influence on growth is an antivernalization effect and may have wide usefulness in the production of hybrid seed, especially if it is shown by plants other than maize. Further experiments are in progress.

Failure of Sodium Salicylate to Inhibit Hyaluronidase *in Vitro*

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When India ink or Evans Blue was injected with hyaluronidase into the skin of rabbits or human subjects following the administration of sodium salicylate, Guerra (*1*) observed decreased spreading as compared with normal controls. If this result was due to the inhibition of hyaluronidase by sodium salicylate, as concluded by Guerra, it should be possible to demonstrate an antagonistic effect of sodium salicylate on hyaluronidase *in vitro*.

Using the broth culture filtrate of a mucoid group A streptococcus as substrate, it was found that 0.005 ml. of a crude bovine testicular extract completely destroyed 0.5 mg. of hyaluronic acid. The addition to the reacting mixture of 5 mg. of sodium salicylate did not decrease the rate of disappearance of the hyaluronic acid, the amount of which was estimated by precipitation with acidified dilute horse serum (*3*).

In a second experiment, 1:100 dilution of crude testicular extract was prepared in 10 per cent sodium salicylate. This solution, as well as a 1:100 dilution of the same testicular extract without sodium salicylate, was tested for its ability to prevent the mucin clot formation by potassium hyaluronate prepared from human umbilical cord (*2*). Both solutions prevented clot formation, again indicating no inhibition of testicular hyaluronidase by the sodium salicylate.

The action of sodium salicylate on streptococcal hyaluronidase was also examined. A broth culture filtrate of a nonmucoid group A streptococcus as a source of the enzyme was combined with a filtrate of a mucoid group A streptococcus containing hyaluronic acid. The enzyme destroyed 0.5 mg. of hyaluronic acid on incubation overnight. The inclusion of 0.1 per cent sodium salicylate in the system did not alter the reaction. When broth containing 10 mg. per cent of hyaluronic acid was inoculated with a nonmucoid group A streptococcus, the hyaluronic acid was destroyed by the time maximum growth was attained. The addition of sodium salicylate to the broth did not retard the disappearance of the hyaluronic acid except in concentrations that inhibited growth. Sodium salicylate, 0.1 per cent, was slightly bacteriostatic; 0.05 per cent inhibited neither growth nor the destruction of the hyaluronic acid.

These experiments fail to demonstrate any inhibitory effect of sodium salicylate on testicular or streptococcal hyaluronidase.

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The Carcinogenic Action of Smegma[1]

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Carcinoma of penis does not occur in people who have been circumcised in the first weeks of life and is rare in people who have been circumcised in childhood or in early puberty. Circumcision in adult life does not affect the frequency of the disease. Phimosis seems to be a predisposing factor. Penile cancer is frequent where personal hygiene is poor; it is rarer where bathrooms are plentiful. All this has been known for decades, and various opinions have been expressed concerning causal relations. Little has been done, however, to establish experimentally the possible carcinogenic action of smegma. Fishman, Shear, Friedman, and Stewart (*1*) injected filtered suspensions of human smegma subcutaneously into 12 young mice of the A strain. No tumors were obtained either in these mice or in 20 young mice into whose distended vaginas smegma was introduced.

In our experiments mice of the Paris R 3 strain were used. No spontaneous malignant tumors of skin and no cutaneous papillomata have been observed in many thousands of mice of this strain in the Crocker Cancer Research Institute. Some of the mice were bred in the Crocker Institute, others in Beth Israel Hospital. They were kept in wooden cages with wire covers, were fed Rockland pellets, and were given water.

Since human smegma, which was used in the first experiments, could not be obtained in sufficient amounts, horse smegma was substituted. This particular substitution was made because penile cancer is frequent in the horse. Smegma is best obtained from dead horses in rendering plants or from anesthesized animals in a department of veterinary surgery. The smegma was kept dry in glass jars in the refrigerator or at room temperature. Generally it was impossible to discover whether the material came from a stallion or from a gelding. One batch was examined for male and female sex hormones, but none were found.

The nonsaponifiable fraction was prepared in the usual way. An analysis for fatty substances gave the following result: total fat, 45 per cent of dry substance (fatty acids, 32.2 per cent; phosphatids, 3.9 per cent; total cholesterol, 6 per cent; cholesterol esters, 2 per cent).

Cerumen, which resembles smegma in being a skin product that is retained on or near the surface of the body, was used

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[1] This study was aided by a grant from the Dora Paul Cancer Research Fund.

as control substance. This could be used because carcinoma of the auditory meatus is very rare in man and animals.

METHOD

A buried skin tunnel, as described in a previous publication (*2*), was made in midline in the middorsal region. Its walls consisted of skin and panniculus carnosus. The smegma, or the cerumen, was kneaded with water into a pulp thin enough to pass through the nozzle of a 2-cc. syringe (bore admitting catgut #3). No needle was used. The nozzle of the syringe was pushed gently into the caudad opening of the tunnel, and the plunger was pushed slowly until the material appeared at the cephalad end. When the skin tunnel broke down (which happened in about 40 per cent of the operations), the substances were injected under the skin or, in the case of the nonsaponifiable fraction, painted on the shaved skin. Benzol was painted on the skin or in the tunnel of 26 control mice. The injections were given every three weeks and sometimes every two weeks. The nonsaponifiable fraction was applied every week or alternated weekly with benzol, in an effort to check the regrowth of hair.

Of the 800 mice used, 250 died too early. Four hundred were treated with smegma. In 190, smegma was put into the skin tunnel; 122 received subcutaneous injections of smegma; and in 88, the suspension of the nonsaponifiable fraction was painted into the tunnel or on the skin surface. Most of the 150 mice which served as controls were treated with cerumen. The mice were operated upon when one month old. The average age at which treatment was started was 65 days for the smegma-treated mice and 68 days for the controls.

RESULTS

There was no significant difference in the survival rates of treated and control mice up to the 400th day of life: 85 and 88 per cent, respectively, after 200 days; 74 and 80 per cent after 300 days; 65 and 57 per cent after 400 days. After 500 days, 47 per cent of those treated with smegma were alive as compared with 30 per cent of the controls. From the 600th day on, there was a marked difference (26 and 6 per cent, respectively), and, on the 700th day, the survival rates were 12 and 1½ per cent. The survival rate of the mice treated with the nonsaponifiable fraction was higher than that of the mice treated with whole smegma.

Microscopic sections of skin and inner organs were available for 212 of the 400 mice treated with smegma and for 80 of the 150 controls. Lung adenomas were found 15 times in the sections of the treated mice and twice in the controls. For lymphoid tumors and leukemia the figures were 15 and 5. Mammary carcinoma occurred 21 times in 105 treated female mice and 3 times in 40 female controls. The mammary tumors did not appear at an earlier age than is usual in the Paris strain. There were eight other spontaneous tumors, six appearing in the mice treated with smegma (adenocarcinoma of kidney, anal papilloma, two so-called hepatomas, one less differentiated carcinoma of liver, one inguinal rhabdomyosarcoma) and two in the controls (hepatoma, perianal subcutaneous spindle-cell sarcoma).

No tumor was found at the site of treatment in any control mouse. The one subcutaneous spindle-cell sarcoma found was situated far away from the site of treatment. *Tumors occurring in smegma-treated mice at the site of treatment included:* four papillary warts, two hornifying squamous-cell carcinomas (one with metastases), one undifferentiated skin carcinoma, and one spindle-cell sarcoma with metastases. Three of the papillary warts were cytologically regular; the fourth, in places, was carcinoma-like. The intrathoracic metastases of one carcinoma contained horn pearls.

There was much variation in the time interval between the starting of treatment and the first evidence of tumor: 36, 82, 122, and 247 days for the warts; 130 days for the sarcoma; 220 and 423 days for the carcinomas. (In the case of one carcinoma the figure is not available.) Thirty-six days is a short but not impossible interval.

The percentage of positive cases was about the same, whether whole smegma (6 in 190) or the nonsaponifiable fraction (3 in 88) was used. Of the four warts obtained, three followed the smegma treatment; of the four truly malignant tumors, two arose after use of whole smegma and two after the nonsaponifiable fraction. No tumors developed at the site of subcutaneous injection of smegma in 122 mice.

DISCUSSION

Considering the nature of the substance used, no strong carcinogenic action (high percentage of positive results) was expected. That any tumors resulted from treating a skin surface with a product of skin epithelium or skin glands might be surprising. At the site of application of a similar substance (cerumen) in 150 mice, no tumors were found.

Among other differences between the smegma-treated mice and the controls, the higher incidence of mammary cancer is noticeable. This point cannot be stressed, however, because of the small number of female controls.

The difference in the incidence of lung adenoma is somewhat suggestive. One may perhaps assume, in the light of the work done by Shimkin and Leiter and by Shimkin and Lorenz (*3*), that the mice absorbed out of the smegma a substance of a certain tumor-forming power.

There is nothing to indicate the possible nature of the supposed carcinogenic factor in smegma. It can hardly be just a result of decomposition in stagnating skin products. If this were the case, one should expect cancers in, for example, the umbilicus of obese people or in dermoid and epidermoid cysts.

The chemical composition of smegma has been studied very little and not recently. For decades histologists have disagreed on the question of whether the glans and the inner layer of prepuce contain sebaceous glands and in what numbers. According to Stieve (*4*), only occasional glands occur, and these play no part in the formation of smegma which, in his opinion, is a product of skin desquamation.

Provided our results can be duplicated and improved, this may be the first experimental production of cancer by external application of an external product of the animal body. There is, however, no way of knowing how far the skin epithelium was intact at the time the tumors developed.

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IN THE LABORATORY

A Simple Laboratory Apparatus for the Demonstration of Cardiac Ballistics

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While the output of the heart is usually considered at some length in the physiology textbook and in the classroom, there appears to be no simple laboratory experiment in common use through which some of the more outstanding features of cardiac output may be demonstrated to the student. Dilution and foreign gas methods of estimating cardiac output and the direct Fick procedure, because of complexity and other reasons, are seldom practicable in the teaching laboratory. Of the secondary methods which may be used, the ballistocardiograph is of great value in studying changes in heart output. However, because of its rather complicated structure and certain technical difficulties, this device is found in relatively few laboratories.

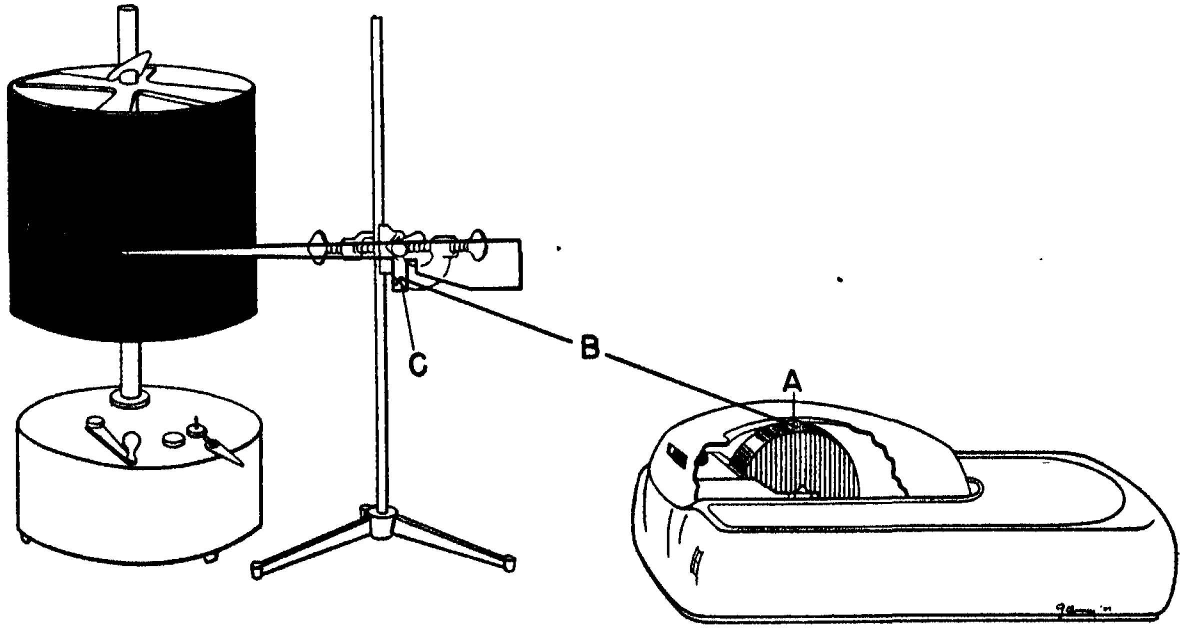

FIG. 1.

In the belief that a less elaborate method of recording cardiac ballistics might be of interest, the description of a simple ballistocardiograph is submitted. The parts required for its assembly are readily available and include an ordinary bath scale, a writing lever, and a kymograph. The arrangement is shown in Fig. 1.

The use of a personal scale in the apparatus stems from the observation that the indicators of certain types of such machines show small rhythmic deflections corresponding to the pulse of the subject being weighed.[1] Because of its small size and construction, this type is the most convenient for the present purpose. While several varieties of these scales are available, the Detecto scale,[2] which registers by means of a vertically placed revolving drum, is best suited. When the subject stands upon the platform, the scale mechanism reaches equilibrium rapidly, but the drum does not remain completely stationary. There occurs a series of slight but noticeable oscillations which are found to correspond in frequency to the pulse rate. These oscillations are, in fact, produced by the recoil of the body from the ejection of blood from the heart and the passage of blood through the aorta.

The writing lever is cut from a thin sheet of celluloid in the shape indicated. The movements of the drum, A, are transmitted to the lever by means of a stiff wire, B, which engages in a small hole at C. The location of the fulcrum and the length of the writing arm are determined by the degree of amplification desired.

The plastic cover of the drum is removed. With the subject standing quietly upon the platform, the wire is attached to the lever at one end and to the drum at the other. The latter is conveniently done by sticking the flattened end of the wire to the drum's surface with a bit of Tackiwax.[3] Finally, the kymograph drum is brought up to the writing point so that light contact is made. The kymograph is run at a speed which shows the characteristic ballistic waves to best advantage.

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[1] A similar observation was made 70 years ago on a different type of scale by Gordon (*J. Anat. Physiol.*, 1877, 11, 533), who recorded these deflections and thus made the first ballistocardiographic tracings.

[2] Detecto Scales, Inc., 1 Main Street, Brooklyn 1, New York.

Fig. 2(A) shows a typical ballistic wave pattern which was obtained with the apparatus described, the waves being indicated by the customary letters. In some records the L, M, and N waves are indistinct. There is some difference of opinion as to whether these are only a result of after-vibrations or are caused by forced movements. Nevertheless, the first and more important waves appear distinctly. While not intended to give quantitative information concerning the cardiac output, this ballistocardiograph does register changes in that value and may be used to demonstrate to the student some of the factors known to influence the output of the heart. Suggested demonstrations are the effects of exercise, normal and sustained respiration, and drugs upon cardiac output. Fig. 2 (B, C, and D) shows records obtained before and after moderate exercise.

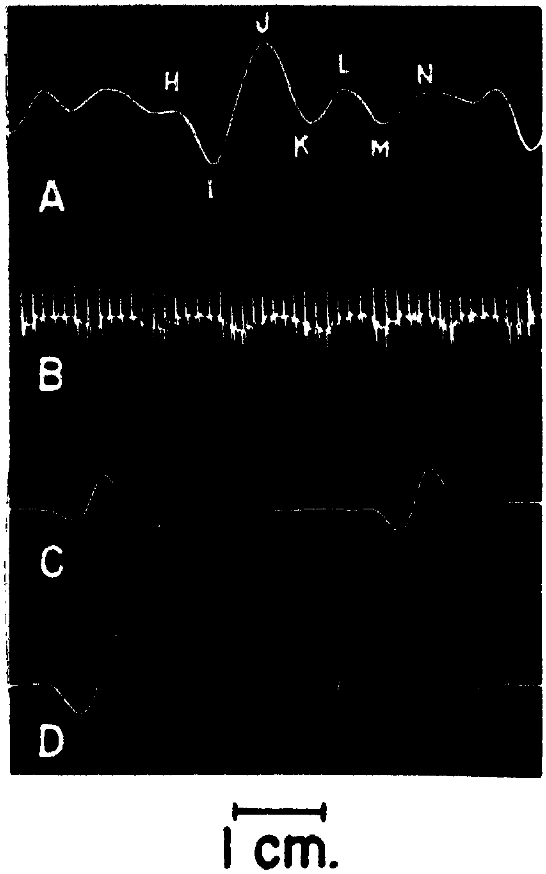

FIG. 2. Tracings obtained with the ballistocardiograph: A, typical pattern with the waves indicated by the customary letters; B, record obtained prior to exercise, with kymograph set at slow speed to show the respiratory waves to best advantage; C, continuation of B with kymograph set at higher speed; D, record of the subject in B and C after moderate exercise. (Note increased I-J distance.)

This ballistocardiograph produces the characteristic pattern of ballistic waves obtained with other, more elaborate instruments. Since the apparatus is inexpensive, is easily assembled, and does not require special training for its successful operation, it may be found useful as a teaching aid in the physiology laboratory.

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[3] Cenco-softseal Tackiwax, Central Scientific Company, Chicago, Illinois.

Control of *Nosema* Disease of Potato Tuber Worm, a Host Used in the Mass Production of *Macrocentrus ancylivorus*

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In several laboratories where *Macrocentrus ancylivorus* Roh., an important parasite of the oriental fruit moth, *Grapholitha molesta* (Busck), is being propagated on the potato tuber worm, *Gnorimoschema operculella* (Zell.), serious losses in the production of parasites have been caused by a *Nosema*[1] disease which infects the tuber worm and the parasites reared from it. Infections of 80 per cent or more in the host stocks are not uncommon, and a large portion of the parasites that are produced on even moderately diseased host material may become infected. Diseased parasites are undesirable because they are short-lived and have lowered reproduction capacities.

Nosema disease in potato tuber worm stocks can be controlled by segregating a few pairs of disease-free moths and breeding them through successive generations in a location free of the disease. Although effective, this method is time consuming, and there is also the constant danger of reinfection.

A practical method of controlling *Nosema* disease was developed from suggestions of the junior author. This method takes advantage of the fact that the disease has been found to be transmitted through the host egg. Eggs of the potato tuber worm on paper sheets, which were obtained by the method described by Marvin (*1*), were placed in a water-tight metal envelope and immersed in a hot-water bath at 47° C. for 20 minutes. It was found that the eggs must be heated before being incubated. This treatment proved to be highly successful, reducing infections in the host stocks that developed from the treated eggs, and in the parasites reared from them, by 75 to 90 per cent. In one test the average incidence of *Nosema* disease in the parasites produced in eight trays that had been stocked with heat-treated eggs was only 2 per cent, as compared with 15 per cent in the parasites produced in four trays stocked with untreated eggs. All the eggs used in this test were from stocks that had received heat treatment in preceding generations. In concurrent tests the incidence of the disease was 44 per cent in parasites reared on host stocks, the eggs of which had not received heat treatments in preceding generations. In eggs that were heat treated after being incubated until nearly ready to hatch, only slight reduction in *Nosema* resulted. In experimental series in which complete production records were kept, the heat treatment that was used did not affect the viability of potato tuber worm eggs or lower the production of breeding stocks of this host insect.

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[1] Determined by R. R. Kudo, University of Illinois, Urbana.

This method for controlling *Nosema* disease lends itself well to the mass-production routine, and with little additional work it insures the production of parasites that are comparatively free of the disease.

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A Single Flashlight Source for Ultracentrifuge Research

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Most of the optical ultracentrifuge observations reported in the literature have been made with the aid of continuous light sources which yield sweep images (*8*). While these are, as a rule, satisfactory for the analysis of sedimenting boundaries and the computation of sedimentation constants and molecular weights, such records give no information on the actual appearance of the sedimenting material. All events occurring at the same latitude of the ultracentrifuge cell are integrated into a continuous streak or sweep across the field of observation. The application of refractive index gradient or schlieren methods to ultracentrifugal problems in conjunction with continuous light sources cannot be expected to reveal local disturbances, e.g. convection or streaming phenomena, existing conceivably in some regions of the sedimenting system.

Bjoernstahl (*2*) has synchronized a light source with the rotation of the rotor of the oil turbine ultracentrifuge to prevent stray light from reaching the photographic plate. Harvey and Loomis (*5*), in their centrifuge microscope, have employed first a stroboscopic and, later on, a semistroboscopic method of illumination for the study of small objects during rotation. A similar device has been suggested by Pickels (*6*) for use with a spinning top. In the course of development of a simple high-speed centrifuge with a plastic rotor (*7*), one of us (K. G. S.) employed a mechanical switch and a General Radio Strobotak light source with promising result. However, the flashing time of the Strobotak lamp amounts to about 1/30,000 second—long enough to cause blurring of the microscopic images even at moderate centrifugal speeds. A preliminary discussion of the problem with Prof. H. Edgerton, of Massachusetts Institute of Technology, led to the conclusion that the recording of images, free of noticeable blurring, would require an illumination time of the order of 1/1,000,000 second when making peripheral observations at ultracentrifugal speeds.

The problem, then, resolves itself into the need for a suitable flash source of high intensity and a synchronizing arrangement which will "trigger" the flash at the instant when the centrifuge cell is aligned with the camera or microscope. The ultracentrifuge[2] used in the present experiments has a vertical lucite rotor, 6 inches in diameter. It is powered by a special electric motor, rated at 35,000 r.p.m. without load, which imparts to the plastic rotor a maximum speed of 21,000 r.p.m. through a flexible shaft, provided the rotor chamber is partially evacuated to reduce air friction.

For general information on flash photography, reference is made to the monograph of Edgerton and Killian (*4*). Whereas Edgerton, *et al.* (*3*) employed a special gaseous discharge tube with three electrodes, a General Electric mercury burner of the H-6 type was used in the present experiments. This light source has previously been employed by Barnes and Bellinger (*1*) in their studies of air-flow phenomena. The basic flash circuit, developed by these authors, was kindly placed at our disposal by N. F. Barnes. A transformer and a rectifier supply about 2,000 volts direct current to a 2-microfarad capacitor which, in turn, discharges through the H-6 lamp. Instead of a manual switch, a thyratron tube was used in the discharge circuit for the control of flashing rate. For triggering and timing the discharge, the light of an automobile headlight lamp is conducted through a plastic strip to the periphery of the porthole in the centrifuge casing. On the opposite side of the rotor a similar plastic strip conducts the light signal to a vacuum photocell. As the transparent sector of the analytical fluid cell passes through the region of the porthole, the light from the source strikes the photocell cathode. The resulting impulse is amplified, squared, and further differentiated by a RC network arrangement. It was found convenient to employ the trailing rather than the leading edge of the cell sector for the initiation of the flash. The amplified impulse is applied to the thyratron tube in the flash tube circuit, which is so arranged that the discharge through the H-6 source occurs precisely at the instant when the cell is in the center of the porthole and thus aligned with the axis of the photographic system. The camera is equipped with a 5-inch focal length lens. For observation by the schlieren method this system is augmented by a schlieren lens and a horizontal knife edge in front of the camera lens, which is adjustable in the vertical direction. The experimental arrangement is shown schematically in Fig. 1.

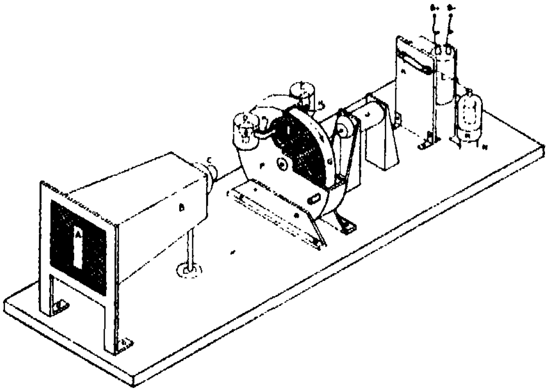

Fig. 1. Experimental arrangement: A, photographic image; B, camera; C, lens; D, synchronizing light source; E, photoelectric cell; F, centrifuge housing; G, plastic rotor with fluid cell; H, transparent plastic strips; J, electric motor; K, B-H-6 mercury lamp; L, 2-microfarad condenser; M, thyratron; N, control grid.

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[1] The kind advice of Prof. W. MacLean, of this Institute, and Dr. F. N. Barnes, of General Electric Company, is gratefully acknowledged.

[2] This was built by the Development Division of the Fisher Scientific Company, Pittsburgh, in cooperation with one of the authors.

The results obtainable with this arrangement are illustrated in Fig. 2a, which represents the photograph of a stationary ultracentrifuge cell filled with water so as to leave a small air space, and in Fig. 2b, a flash image of the same cell, recorded by a single discharge at approximately 10,000 r.p.m. The air-water meniscus, which is curved in the stationary picture, becomes practically a straight line. The slight blur at the trailing edge of the cell sector image is probably due to an afterglow phenomenon in the discharge tube.

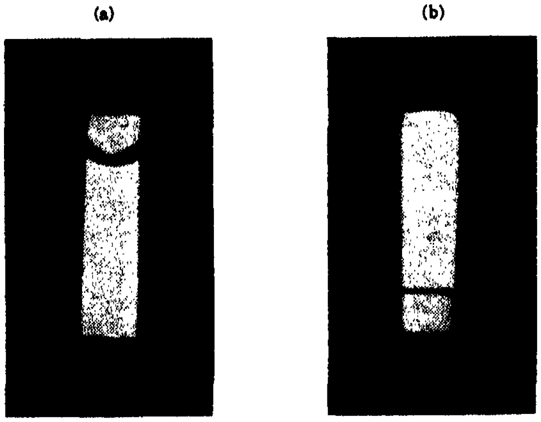

FIG. 2. Flash photographs of centrifuge fluid cell at rest (a) and in motion (b).

Images of macroscopic objects during flight may be recorded without appreciable distortion. Fig. 3a is the picture of a stationary, star-shaped object which was attached to the outside of a clear plastic plug inserted in the opaque rotor. Fig. 3b represents the image of the same object, photographed with a single flash during rotation at about 4,000 r.p.m. The sedimenting boundary of tobacco mosaic virus protein has been photographed by the schlieren method with the aid of single light flashes.

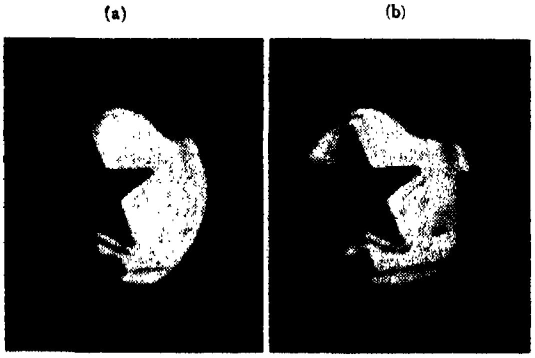

FIG. 3. Flash photographs of star-shaped object at rest (a), and in flight (b).

It is evident that the arrangement here outlined lends itself, in principle, to other applications, e.g. the photomicrography of small objects, such as individual cells, and to studies of photoelastic stress patterns in polarized light. A full report of this work will be published elsewhere.

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An Apparatus for the Determination of the Tensile Strength of Healing Wounds

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The role of nutrition in wound healing has been the subject of few quantitative studies. Harvey and Howes, in their studies on the effect of nutritional state on the rate of healing of wounds, used tensile strength as a measure of repair (*1*, *2*).

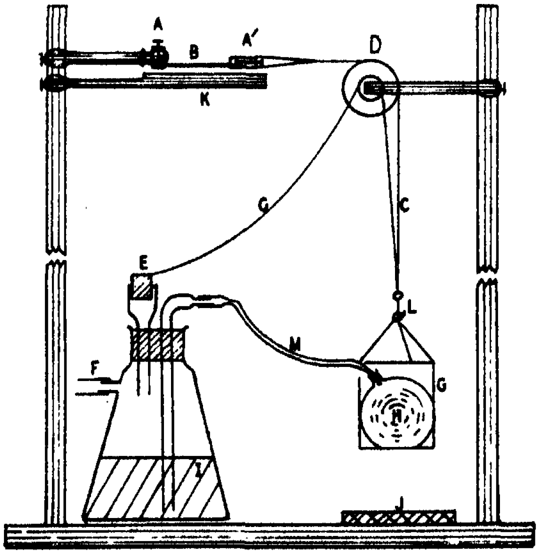

FIG. 1. Arrangement of apparatus: A-A′, screw clamps; B, strip of skin to be tested; C, braided nylon cord; D, pulley; E, rubber stopper; F, compressed air line; G, cardboard container; H, rubber balloon; I, mercury; J, cushion; K, support plate; L, hook; M, rubber tubing.

In the course of our work on the role of protein nutrition in wound healing, a simple, semiautomatic apparatus for measuring the breaking strength of skin wounds was devised.

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[1] The authors wish to thank Miss Lois H. Henneberger and Miss Mary A. Lord for their technical assistance.

The apparatus allows a uniform rate of loading, can be constructed easily with ordinary laboratory equipment, and is simple and rapid in operation.

In order to determine the strength of a wound, a 0.50-cm. strip of skin is cut out at right angles to the wound. The ends of the strip are fastened to clamps A-A′, the support plate K facilitating manipulation of the strip. The apparatus is arranged as shown in Fig. 1, and compressed air is turned on at F, driving mercury into the balloon, H, at 900–1,100 grams/minute. When the limit of strength of the skin strip is attained, it breaks and container G falls, pulling out stopper E and automatically halting the flow of mercury. Container G is then weighed without detaching from the apparatus.

The reproducibility of the results obtained is indicated by determinations of the breaking strength of similar 0.50-cm. strips of freshly dissected, unwounded rat skin. Determination on 10 rats (135–190 grams in weight) gave values ranging from 1,410 to 1,990 grams; the average value was 1,710 grams, and the average deviation, 170 grams.

An experiment demonstrating the possibilities of this approach to the study of wound healing was set up as follows:

Young male rats (140–160 grams) were divided into two groups and fed ad libitum diets containing 6 per cent and 22 per cent casein. The percentage composition of the diet for each group is given below:

	Group I	Group II
Casein	6	22
Dextrose	73	57
Salt mixture No. II (SMA)	4	4
Crisco	15	15
Cod liver oil	2	2

The rats were given a daily supplement of thiamine, pyridoxine, riboflavin, calcium pantothenate, and choline chloride and were supplemented weekly with vitamins A, D, and E.

After 7 days on diet, the rats were anesthetized with nembutal and ether, and the hair in the area of the shoulder blades removed with a pair of clippers. A slit wound (approximately 1 cm. in length) was made longitudinally through the entire thickness of the skin with a scalpel. The edges of the wound were pressed together, and a strip of adhesive tape applied directly to the wound. The edges of the tape were cemented to the skin with a methacrylate polymer mixture consisting of: hydroabietyl alcohol, 20 grams; dibutyl phthalate, 15 grams; isobutyl methacrylate polymer, 50 grams; isobutyl-N butyl methacrylate interpolymer, 40 grams; and toluene, 150 ml.[3]

The hind paws of the rat were incased in test-tube ends filled with plaster of Paris in order to prevent the animal from scratching at the wound. (Further experience has shown that this precaution is unnecessary.) The dressing adhered for approximately 10 days, after which the wound had healed sufficiently to render protection unnecessary. With this technique close proximation of the wound edges was obtained; infection and scabbing rarely occurred.

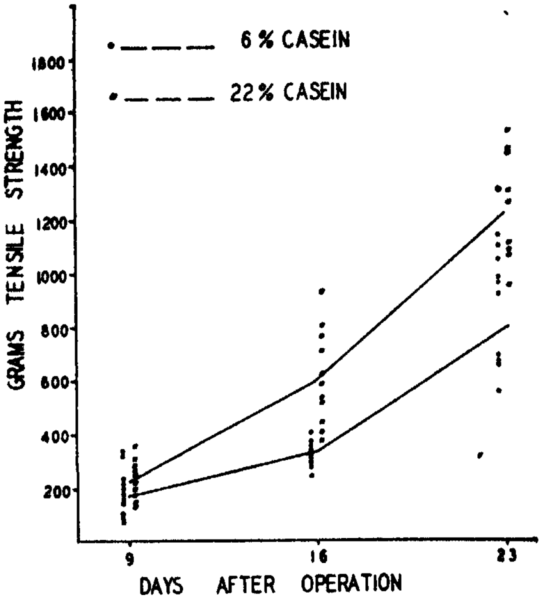

Fig. 2.

After 9, 16, and 23 days, the animals were sacrificed and wound strength determined (Fig. 2). The average error and calculations of significance of each group of rats are given in Table 1.

The data shown in Fig. 2 and Table 1 demonstrate the unfavorable effect of suboptimal dietary protein level on the rate of healing of skin wounds in the rat. This has been confirmed by several repeat experiments using the same technique and apparatus. The data serve to confirm the report of Harvey and Howes on the beneficial effect of high protein diets on the healing of experimental wounds.

TABLE 1

Relationship Between Dietary Protein Level and Breaking Strength of Skin Wounds

	6% Casein		22% Casein		Critical ratio (3) $\left(\frac{x}{\sigma}\right)$	Probability of significance (3)
9 days	10 rats	178 ± 67 grams	10 rats	229 ± 47 grams	1.5	6 to 1
16 "	9 "	314 ± 36 "	11 "	602 ± 135 "	5.2	2 × 10^6 to 1
23 "	11 "	800 ± 223 "	9 "	1,222 ± 264 "	4.0	1.5 × 10^4 to 1

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[3] The methacrylate polymers were supplied by E. I. du Pont de Nemours and Company, Wilmington, Delaware.

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While not professing to be a systematic development of the principles of analytic dynamics, this useful booklet presents an interesting approach to a set of problems which are usually regarded as difficult by the student. It selects for consideration the motion of bodies in accelerated reference systems and derives from Newton's laws or Lagrange's equations the basic laws of motion, which are applied to specific instances. The treatment includes the general motion of a rigid body, motion relative to the rotating earth, the motion of a top, and Euler's dynamical equations. One chapter is devoted to the dynamics of an inextensible flexible chain; it excels in elegance and clarity.

Throughout the book, problems are chosen for their illustrative value and mathematical tractability, and without reference to their practical importance. The contents are meant to be supplementary to the standard treatises on dynamics.

The book should prove valuable in the hands of a teacher of graduate courses in dynamics who wishes to enliven the treatment of the subject by interesting and unorthodox examples.

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Scientific Book Register

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A Chemist's View of Nutrition

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OVER 150 YEARS AGO LAVOISIER, WHO is recognized as the father of the science of nutrition, stated: "La vie est une fonction chemique." Since that time chemistry has played the central role in the development of nutrition knowledge. The development has been accelerated as organic and physical chemists, as well as biochemists, have recognized nutrition as a worthy field of activity.

In 1912 the existence of the first vitamin was definitely proved—as a *something*, a quality, a property, or perhaps a substance, which some foods had and others did not. Other vitamins became thus recognized in succeeding years, but it was not until the organic chemist commenced to give these "somethings" attention that the field really moved. It was over 15 years after the first vitamin was discovered that the chemical nature of any of them was definitely established. In the succeeding years, isolation, determination of structure, and, frequently, synthesis followed increasingly closely on the biologists' discoveries. In fact, the organic chemist has assumed the role of discoverer, or at least the final arbiter, as to whether a proposed vitamin is entitled to be considered a separate entity. The elucidation of the folic acid puzzle, which has resulted from the determination of the structure of the *Lactobacillus casei* factor through analysis and synthesis, is a striking example. Synthesis, particularly on a commercial scale, has given a tremendous impetus to the advancement of vitamin research as well as to human medicine.

While chemistry is making new discoveries which may enhance the importance of nutrition, it can also play a major role in keeping nutrition practice sound. The over-exploitations of the last few years, which have embarrassed the true nutrition scientist and hurt the cause of nutrition, can only be combated by clearly established facts. Optimum nutrition certainly will not be accomplished by saturating the body with a few vitamins, with lesser attention accordingly to other essential nutrients.

Nutrition deals with proteins, energy-forming nutrients, minerals, and vitamins, but these nutrients must be translated into foods. Thus, nutrition must deal with both body needs and food supplies. Chemistry is concerned all the way across the board from production through processing and storage to the home preparation of food, as well as with what happens to it inside the body. Body needs must provide the basis for determining the kinds and amounts of food supplies required, and here much more needs to be learned.

First of all, we need a better understanding of the biochemistry of body processes and, particularly, of the specific chemical reactions in the body for which certain nutrients are essential. We know that thiamine is a constituent of the enzyme, carboxylase, essential for the removal of pyruvic acid, an intermediate in carbohydrate breakdown, and thus we can relate the requirement of the vitamin to the intensity of energy metabolism. In the case, however, of vitamin D, the chemistry of which has been known for years, we can only make the general statement that it is essential for normal calcium and phosphorus metabolism. How or when it acts we do not know. Our specific knowledge of body requirements is, accordingly, much less. The same situation holds for certain other essential nutrients, both vitamins and minerals.

It is clear from discoveries to date that enzyme chemistry particularly has a lot to contribute to our knowledge of body processes and nutrient functions. Several vitamins have been recognized as a result of investigations of enzyme systems in the living cell, and such studies will continue to increase our knowledge of the most intricate metabolic processes.

Our understanding of nutritional requirements during the last half of life is much less than for the period of growth, because we know less about the tissue changes which are taking place. A child falls down, jumps up, and goes blithely on his way. An old man falls down and breaks his hip. What differences in the physicochemical structure of the bones are involved? We understand the role of nutrition in building bone during growth, but little about its possible contribution in retarding aging changes.

While it is probable that some dietary essentials remain to be discovered, much more needs to be learned regarding the quantitative requirements of the ones now known. The amounts needed to prevent and cure the physical symptoms of specific deficiencies are understood. But when we try to specify the higher levels that are desirable for optimum body functions, we approach the realm of speculation. We do not know what this optimum condition is with respect to a given nutrient and, thus, how to arrive at the quantitative requirement. The chemist must help in identifying the significant metabolic changes involved, in devising methods which can be readily ap-

An address presented before the New York Section of the American Chemical Society, December 6, 1946.

plied for detecting their abnormalities, and in ascertaining the quantitative role of specific nutrients in preventive and curative measures.

It takes around 100 mg. of vitamin C daily to keep the body saturated with this vitamin, as indicated by blood levels and urinary excretion. Yet, as little as 30 mg. appears to protect the body against any physical symptoms of scurvy. In fact, according to a preliminary report, a recently completed English study failed to find any physical signs of deficiency from feeding as little as 12 mg. over a period of a year to subjects previously on high intakes. Vitamin C is concerned, however, with the health of all tissues in the body, not merely the skin and gums which provide the external physical symptoms. In the English subjects the blood vitamin level rapidly dropped to nearly zero. What is the significance of blood level anyway, and where should it be maintained? How is it correlated with changes which affect health?

Questions of this sort need to be answered for several nutrients. The nutrition scientist has learned that it is unwise to be content with absence of physical symptoms. Further, it is wiser to specify unnecessarily high intakes than to run the risk of injury to health. But we need more exact bases for our recommendations than we now have. There is increasing evidence that for certain nutrients a limited intake may be preferable to an overgenerous one.

These questions have an important bearing on the food economy which deals with the kinds and costs of the family food, the character of the food supply needed by populations, and the plans which must be made accordingly. These economic considerations have been of paramount importance in rehabilitation activities, and the lack of more reliable bases have been a serious handicap. Economic as well as health aspects will continue to constitute important reasons for more specific knowledge in any world program such as that envisaged by the Food and Agriculture Organization.

We need new techniques for studying human metabolism directly, but a large place remains for animal studies in order to learn basic reactions with species which can be closely controlled and which are also expendable, before subjecting humans to experimental restrictions. Here, farm animals as well as laboratory animals have a place. Some of the most important discoveries affecting both human and animal nutrition have been made with farm animals—vitamin discoveries with chickens and hogs, mineral discoveries with cattle and sheep, for example. Many findings with these animals require testing for their human applications. It has been found that .1 mg. of cobalt daily makes the difference between life and death in a sheep; a lack of this minute amount was responsible for the death of tens of thousands of animals yearly before the discovery was made. This mineral is probably unimportant in human nutrition, but we are not sure about this.

Thus, in many respects, we know more about feeding farm animals than feeding people. Economic and other aspects have been studied through continuing large-scale programs in every state experiment station and in government laboratories. But, by and large, the output of basic knowledge has been limited in terms of the expenditures made because of a lack of realization by the leaders as to what chemistry and physiology might contribute and by the scientists as to the opportunities for making fundamental discoveries of importance to human health as well as to animal production.

The purified diet method has proved one of the most effective procedures in modern nutrition research, particularly as commercial sources of synthetic vitamins and amino acids have become available. Its early use with rats and dogs has now been extended to several other species, including man. With its increasing use and development, however, certain possible limitations have become evident. These are being taken account of in current research.

Amino acids are coming into increasing use in purified diets as a method of determining their quantitative requirements. Recent research, however, has raised an important question with respect to the use of amino acids to supply the entire protein component of a purified diet. It has been observed repeatedly that the growth rates obtained in experimental animals on amino acid mixtures are not as rapid as when protein of high biological value is employed. Both Woolley and Rose have recently reported evidence that certain intact proteins contained a growth factor apparently different from any of the amino acids obtained on their hydrolysis. Specifically, Woolley found that strepogenin, a peptide-like bacterial growth factor present in casein but destroyed on acid hydrolysis, was an effective supplement to a casein digest. These brief reports indicate clearly that the nutritional properties of proteins, as normally obtained in a purified state, may not reside solely in the amino acids resulting from their hydrolysis. Does the protein molecule contain other essential structures besides amino acids, or do proteins, as normally purified, contain extraneous growth factors bound to them?

Purification processes change the physical nature of proteins as they occur in foods. May some of the extreme procedures change the nutritive value of naturally-occurring protein molecules and thus limit the application of the results obtained with purified diets?

Clearly, one of the differences between purified diets and those made up of natural foods lies in their different effects on vitamin synthesis in the intestine—a process now recognized to be important in several species, including man. Different carbohydrates, originally considered interchangeable in purified diets, have been found to exert variable effects on vitamin synthesis in the intestinal tract and thus on the over-all result obtained. For example, lactose and starch are more effective than sucrose in promoting riboflavin synthesis. The recent findings with purified diets, that tryptophane lessens the dietary need for nicotinic acid, have been explained on the basis that tryptophane promotes the intestinal synthesis of the vitamin, perhaps as a precursor. While this tryptophane-nicotinic acid relation has been suggested as a reason for the pellagra-promoting effect of corn, the finding of Woolley that corn contains an antivitamin which competes with nicotinic acid provides another explanation. This whole subject of antivitamins should intrigue the chemist.

Whatever may be the explanation of some of these recent findings with purified diets, it must be recognized that the results obtained with large amounts of pure nutrients may be quite different from those obtained with the natural foods of which our diets are composed. The basic value of the purified diet method is not thus impaired, but interpretations must be reconsidered accordingly.

The body requires countless organic compounds for its metabolism. Most of them are supplied by the proximate principles and their metabolites. Others are not so supplied and become separate dietary essentials, except as some of them are synthesized in part or in whole in the intestine. These generalizations we understand, but the details which influence both quantitative and qualitative dietary requirements require much more study. What are the precursors of the nonessential amino acids, and under what conditions may they be deficient in the diet? What is the precursor of vitamin C in the diets of those species which synthesize it, and is this precursor always adequately supplied?

All of these studies of body needs must be paralleled by equally important ones dealing with the food supply. There are still many nutritive factors which must be tagged chemically, and quantitative methods for their determination must be worked out. The latter job cannot be shifted entirely to the microbiologist, despite the remarkable contributions he is making. Take the case of vitamin B_6 as an example. After pyridoxine was isolated as this vitamin and after much was learned about its distribution in foods, two more active compounds, the aldehyde and the amine, were discovered and found to behave differently to the test organisms used in assaying pyridoxine. New active forms are being found for several of the vitamins. Chemical methods, as well as biological studies with appropriate higher animal species, must continue to be used in the development of suitable microbiological procedures.

Chemistry must continue to play an important role also in the development of methods for the quantitative determination of amino acids in foods. These methods must be perfected if we are to put nutrition on an amino acid basis.

It must be recognized, however, that quantitative data on the food supply are not the whole story. Questions of availability and degree of utilization arise. Chemical or microbiological data on amino acid content must be checked by animal studies of the biological value of the protein concerned. Animal experiments show that heat improves this value for the protein in some foods, such as soybeans, and hurts the value in other foods, such as cereals. Yet, in neither case has amino acid content been altered appreciably according to recent studies. It is considered in the case of soybeans that heat destroys an interfering antienzyme. This explanation raises the general question as to what extent heat or other conditions to which food is subjected before it reaches the table affect the activity of either enzymes or antienzymes concerned.

Further studies need to be made on the extent to which the amino acid mixture found in the food corresponds to the resulting metabolic mixture presented to the tissues for utilization. A recent report by Melnick suggests that the actual biological value of a given protein intake may be markedly different from that suggested by its amino acid make-up, because these acids are liberated in digestion at varying rates and thus absorbed at different times. The mixture presented to the tissues differs accordingly.

In supplying body needs the nutritionist must deal with the nutritional quality of foods as they reach the consumer's table. It is recognized, however, that this quality depends upon many previous operations. From this standpoint, nutrition actually begins with the soil, because how food crops are produced markedly influences their nutrient content. The practical importance of the nature of the soil has long been evident in terms of the nutrition and health of grazing animals. The case of cobalt has been mentioned. A similar story could be told for phosphorus, copper, calcium, and other minerals. Whether it is practicable and important in human as well as animal nutrition to make good these deficiencies through fertilization constitutes a question of prime importance. We do not have today, however, any general formula for soil treatments which can be counted on to eliminate these deficiencies in food crops. The soil is a complex physical, chemical, and biological system, and basic studies rather than trial-and-error methods are required to obtain significant data.

We need to know how soil deficiencies affect not only the mineral content of food, but also its organic constituents. Here we are concerned with the amount and biological value of the protein present and also with the vitamin relations. Almost all of the vitamins needed in the human diet are products of plant metabolism. It is reasonable to believe that their formation is influenced by cultural conditions, and yet we are very ignorant of this phase of plant physiology. There is need for the same basic chemical studies of the metabolism of vitamin formation in our food supply as are being carried out in connection with vitamin utilization in the body.

The practical importance of the soil in relation to the nutritional quality of the human food largely remains to be demonstrated. In the meantime, however, enthusiasts are extolling soil treatments as the solution for human ills. It is unfortunate to have the public warned by a responsible writer that "the baby won't have good bones if its formula is made of milk from a cow whose feed came from a soil deficient in calcium and phosphorus" and that "the adult won't build muscle and good red blood from a steak devoid of protein-building minerals and iron." No alteration of the ration, much less of the soil, can influence in any significant way the amount of calcium, phosphorus, protein, or iron an animal puts in its milk or its muscles. It takes a lot of effort to counteract the effects of such statements, even when all the scientific facts are available. Even though the extreme claims obviously are untenable, much more research is needed in the general field, because it seems clear that when all the facts are known, generalizations of practical value can be established.

Some important relations between climate and nutritive value have already been established. For example, research has clearly shown, in the laboratory and in the field, that light intensity prior to harvest has an important influence on the vitamin C content of certain fruits and vegetables. It has been demonstrated experimentally that the concentration of this vitamin in turnip greens increases 8-fold in a week as the light intensity is increased from 200 to 5,000 foot-candles. We cannot expect to control climate, but we can take climate into account in deciding where certain crops should be grown. We may modify certain greenhouse practices where nutritive value is markedly concerned.

The variety of the specific crop grown is also important. Different varieties of a given fruit or vegetable may differ widely in certain nutritive values when grown side by side in the same soil during the same season. It seems clear that in breeding for yield and so-called market quality, nutritive values have been adversely affected, in some instances at least. More important, it has been shown that new varieties with higher nutritive values can be developed through appropriate breeding and selection. In fact, this may well prove to be the most effective way of improving the nutritional quality of our food supply as produced.

The progress already made in this general field of food crop production makes it clear that the problems are of sufficient importance and the results to date sufficiently promising to justify research programs of a magnitude and character essential to explore fully the possibilities involved. Integrated studies by soil, plant, and nutrition scientists are called for to provide data which can be translated into reliable and practicable field procedures. Quick results are not to be expected. It took many decades to develop the present knowledge as to how to control cultural factors in the interest of maximum yield and desirable market qualities. Nor can one predict how important and how practical the final results will prove to be. As in the case of all other research, the answers can come only when all the facts are known. In such a program the chemist must play a large role.

With respect to products of animal origin, the principal factor causing nutritive variations is the feed of the animal. The vitamin value of butter is the outstanding example here. The mean annual potency of the butter produced in this country is around 15,000 I.U./pound. While summer butter is much richer than this general average, most of the winter butter ranges around 9,000 units. It would be entirely possible to raise the value of this winter butter and, more important, of the fluid milk supply by 50 per cent through appropriate feeding practices. These practices should not increase the cost of milk production, because the foods which will step up vitamin A value are those which will make the ration better in terms of total production as well.

Similarly, the vitamin A and vitamin D contents of eggs are markedly affected by the nature of the ration. Here again, the rations which promote the highest production also improve the nutritional quality of the eggs.

The importance of processing and storage factors in the nutritive value of food as it reaches the consumer is too well appreciated to call for any detailed comments. This has been a very active field of research during the war years. That much remains to be done is obvious. I think that advancement in this general field is being somewhat handicapped because so much of the research is on a commodity basis. This is the natural basis for the manufacturer or distributor who has a specific commodity to sell. It is the basis on which most of the state- and federally-supported research is organized. It overlooks the fact that biochemical changes are not peculiar to a single commodity, and, thus, the basic physical and chemical reactions and interreactions which may have a common influence on nutritive value, palatability, and other important qualities in many products particularly need attention. Chemists are more likely to be interested in basic reactions than in pecans, prunes, or some other special commodity for which a laboratory may be organized. More recognition of the importance of basic research would attract better scientists and thus make food research more productive.

In terms of consumer acceptance, palatability ranks above nutritive value, in part at least because palatability is the more obvious quality. It rests primarily on subjective measures. Biochemical measures are certainly needed, and here lies a very complicated problem indeed. Such measures would be useful all the way from the farm to market. Recent trends, in the marketing of fresh foods particularly, have tended to work against both palatability and nutritive value because the avoidance of losses through spoilage and the maintenance of a fresh, firm appearance have become so important in market quality. Fruits and vegetables are now being bred with these factors in mind and are being picked green to ripen in shipment or in storage. Both nutritive value and palatability suffer accordingly. Perhaps the chemist can help develop products which will be of the desired market quality in all respects through a better understanding of the basic changes involved.

In all research dealing with the food supply, it is clear that the economic aspects cannot be neglected. Since malnutrition is most prevalent among low-income groups, cheaper as well as more nutritious foods are called for. This means all possible economies in production and distribution, particularly in the case of the more nutritious and preferred products. But attention to low-cost foods which are widely consumed, though not outstanding in any particular nutrient, is also important. Potatoes are such a food. If all the potatoes consumed in the United States in 1945 contained, as eaten, the vitamin C present when they were dug, over half the recommended allowance for our entire population would thus have been met. Unfortunately, most of it was lost before it got to the table. The actual amount of the losses is not known, but they can be as high as 50 per cent or more in storage, depending on how the potatoes are stored and for how long, and from 15 to 60 per cent or more of what is left can be lost in cooking. A substantial part of these losses could be prevented. Potatoes, as now marketed and consumed, do not get the credit they deserve in terms of vitamin C content, but more attention to conserving the nutritive values of this cheap, everyday food would do much to improve nutrition where the need is greatest, namely, among the low-income groups. It would greatly increase the value attached to potatoes as an article of the diet. Cooking losses must be accepted, but they can be reduced by taking advantage of facts now established. Storage losses merit much more study. In terms of national nutrition, foods which are rich sources of a given nutrient may be less important than a poor source which, because of its much larger consumption, makes a larger per capita contribution of the nutrient in question.

When the need for the improvement of the nutritive value of the food supply is mentioned to leaders in either agriculture or the food industry, a frequent response is: "It will cost money; will the consumer pay more accordingly?" The fact is that the consumer is, in many instances, not now getting the nutritive value he thinks he is paying for because of modern marketing developments. When he comes to realize this, the market for present products may be adversely affected. Further, it is a false assumption that improving nutritive value must mean a more costly product. As Dr. Wade, director of the Breeding Laboratory at Charleston, puts it in the case of improvement through breeding:

> If some agency interested in the public welfare absorbs the cost of research in the production of new varieties with improved nutrition values, then there is no reason for the public's paying increased prices. Our experience in breeding improved varieties would indicate that those with high nutritive value can be as productive as those with lower values.

Almost the entire biological cycle has been covered in this discussion of food problems beginning with the soil and ending with the excretory products resulting from food metabolism. The nutrition scientist has a real interest in all of the problems involved, in promoting and assisting in their study, and in seeing that nutrition goals are kept in mind. Some of them are so interrelated that they should be studied together rather than piecemeal. Coordinated attacks by men with varied training and interests are called for. A wider recognition as to how these diverse problems are related to the advancement of nutrition should make the individual worker more effective in his specific area, as well as serving to promote the integrated research called for in the over-all field. In such a program the chemist must continue to play a primary role.

Legislation Affecting Scientists in the Armed Forces

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TWO BILLS HAVE BEEN INTRODUCED into the 80th Congress which, if passed, would have widespread effects upon the status and effectiveness of scientific personnel in the Armed Services. These indicate the necessity for closer scrutiny of Service scientific programs by civilian scientific groups.

During World War II no lesson was driven home more forcibly than the importance of scientists in national defense. Large numbers of scientific personnel were utilized in research, selection, operations, and training. It may be assumed that the Armed Services will continue to conduct research in peacetime and to enlist the assistance of civilian groups.

Although there may be differences of opinion as to the amount or type of research which should be performed within the Armed Services, there is no question as to the importance of at least some scientific personnel in these Services. First, such personnel is required to perform whatever research the Services will do. Second, it is required in establishing policies at high levels, as exemplified by the Joint Research and Development Board. This group is especially important and calls for men with a great appreciation of the scientific point of view not only to insure adequate exploitation of scientific advances but also to establish and carry out necessary over-all research plans. This includes planning for and supporting research within the Armed Services themselves as well as in civilian institutions where Service-sponsored projects are undertaken. A third purpose is to review continuously research results from civilian laboratories to discern those which may be of importance in promoting national defense, at the same time serving as a bridge across the gap which usually exists in peacetime between military personnel and civilian scientists.

The organizational structure, magnificent facilities, and a potentially ideal environment for research are now in existence within the Armed Services. However, it must be recognized that the entire scientific program of these Services is potentially impotent without competent scientific personnel. The responsibility for the success of this program rests on the shoulders of both the Armed Services and the entire group of scientists in the United States. If a scientist possesses a skill which can be utilized in national defense, it is inevitable that he will be called upon as soon as even a potential emergency appears. Although he may not be placed in uniform, he will, nevertheless, have a very tangible connection with the military effort. The civilian scientist should insist that there be a sound research structure within the Armed Services not only because of his interests in national defense but also because of a more selfish interest—assurance of his maximal utilization in the capacity for which he is best suited in the event of an emergency. The importance of this cannot be overemphasized.

The mobilization of science in World War II began in 1940 with the establishment of the National Defense Research Committee. During the war a large number of scientists found themselves either in the Armed Services or working under OSRD contracts. With the cessation of hostilities, it was logical for this mobilization to be reduced. However, the number of scientists who left the Armed Services was entirely out of proportion to the decreased requirements—so many left as to seriously hamper military research efforts. The situation is summarized in the following statement taken from the history of the Armored Force Research Laboratory, published shortly after V-J Day.

> The fact that not one of the members of the laboratory staff was interested in staying in the peacetime Army or continuing to do research under the Army is silent testimony which has a self-evident interpretation. Unless the Army is able to attract personnel of a high type, its program of research will die in infancy. This is true whether the program is set up within the Army or carried on by civilian scientists under the auspices of the Army (*i.e.* Civil Service).

This experience was not limited to one laboratory, and nowhere is it more applicable than to the facilities and personnel of the Medical Departments of the Services.

Under the aegis of the Medical Department, biological scientists made great contributions to the solution of problems arising as a result of scientific advancements which increased tremendously the performance of weapons and machines without concomitant increases in human capabilities.

The success of the various activities staffed by scientific personnel, including the Service research laboratories, the Aviation Psychology, Aviation Physiology, and other programs, brought to the Medical Departments the realization of the necessity for continuing these functions. This realization has led to the introduction into Congress of the two above-mentioned bills which bear directly upon the problem of the status of the biological scientist in the Armed Forces. These bills, pertinent sections of which follow, have been referred to the Senate Committee on Armed Services.

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S. 334

A bill to establish the Medical Associated Sciences Corps in the Medical Department of the Navy, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That there is hereby established the Medical Associated Sciences Corps which shall be a constituent part of the Medical Department of the Navy and which shall consist of not more than two hundred and five officers of the grade of medical associated scientist. Officers of the grade of medical associated scientist shall have the rank of captain, commander, lieutenant commander, lieutenant, or lieutenant (junior grade), and such officers shall be part of the authorized strength of the various corps of the Medical Department as now exist or may hereafter be established.

Sec. 2. Medical associated scientists shall be staff officers and shall be subject to all provisions of law now existing or hereafter enacted relating to the advancement in rank and retirement of officers of the Medical Corps. No officer of the Medical Associated Sciences Corps shall be entitled to command in the line or any other staff corps of the Navy, nor shall any officer suffer reduction in pay or allowances by reason of appointment in accordance with this Act.

Sec. 3. All appointments to the grade of medical associated scientist shall be made by the President, by and with the advice and consent of the Senate, and shall be from male citizens of the United States who shall have received a doctorate degree in such sciences related to medicine that the Secretary of the Navy shall determine.

* * *

Sec. 5. All appointments to the grade of medical associated scientist, except those provided for in section 4 of this Act, shall be with the rank of lieutenant (junior grade) from male citizens of the United States between the ages of twenty-one and thirty-two years. No person shall be appointed pursuant hereto until he shall have established his mental, moral, physical, and professional qualifications to the satisfaction of the Secretary of the Navy.

* * *

S. 504

A bill to revise the Medical Department of the Army, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "Army Medical Department Act of 1947."

Title I

Medical Service Corps

Sec. 101. Effective the date of enactment of this Act, there is established in the Medical Department of the Regular Army the Medical Service Corps, which shall consist of the Pharmacy Section, the Medical Allied Science Section, the Optometry Section, and such other sections as may be deemed necessary by the Secretary of War, and which shall perform such services as may be prescribed by the Secretary of War. The authorized strength of the Medical Service Corps, Regular Army, shall be such strength as may from time to time be prescribed by the Secretary of War. The Medical Service Corps, Regular Army, shall consist of officers in the grades of second lieutenant to colonel, inclusive: *Provided*, That the number of colonels on active duty in the Medical Service Corps, Regular Army, shall at no time exceed 2 per centum of the authorized Regular Army officer strength of such corps.

Sec. 102. (a) From the officers commissioned in the Medical Service Corps, Regular Army, in the permanent grade of major or above, the Secretary of War shall appoint the Chief of the Medical Service Corps who shall serve as such Chief during his pleasure, and who, if commissioned in permanent grade below colonel shall, without vacation of his permanent grade, have the temporary rank, pay, and allowances of a colonel while so serving, and who, while so serving, shall be superior in rank to all other colonels in the corps.

(b) From the officers commissioned in the Medical Service Corps, Regular Army, the Secretary of War shall appoint such assistant chiefs, who shall be chiefs of sections, and who shall be consultants to the Surgeon General in activities relative to that specific section.

* * *

Sec. 103. Except as provided in Public Law 281, Seventy-ninth Congress, approved December 28, 1945, as amended, and except as hereinafter provided for transfer thereto, original appointments in the Medical Service Corps, Regular Army, shall be made only in the grade of second lieutenant from citizens of the United States between the ages of twenty-one and thirty years, who possess such physical and other qualifications as may be prescribed by the Secretary of War.

Sec. 104. Effective from date of enactment of this Act, commissioned officers of the Medical Service Corps, Regular Army, shall be promoted to the grades of first lieutenant, captain, major, and lietuenant colonel as now or hereafter prescribed for promotion of promotion-list officers to such grades, respectively. Promotion to the grade of colonel shall be by selection under regulations prescribed by the Secretary of War from officers in the grade of lieutenant colonel with at least one year's service in that grade.

* * *

The bill then provides that Public Law 281, as amended, be further amended by inserting in lieu of paragraphs (c) and (d), Section 5, of the Act the following paragraph:

Sec. 105. "(c) Persons appointed in the Medical Service Corps shall be appointed in grades of second lieutenant, first lieutenant, captain, or major according to the periods of service with which they are credited in the same manner as set forth in paragraph (a) of this section for persons appointed in arms and services of the Regular Army, the officers of which are on the promotion list."

* * *

Sec. 106. Officers of the Regular Army who, on the date of enactment of this Act, hold commissions in the Pharmacy Corps, are, effective the date of enactment of this Act, transferred in grade to the Medical Service Corps. Each such officer so transferred shall be reappointed in the Medical Service Corps in the permanent grade held by him at the time of such transfer; shall be credited for the purpose of determining eligibility for promotion, with continuous commissioned service on the active list of the Regular Army in the Medical Service Corps equal to the period of service credited to him for promotion purposes under existing provisions of law, and shall, subsequent to such transfer, be thereafter promoted in accordance with the promotion system set forth in section 104 of this title.

Sec. 107. (a) Effective the date of enactment of this Act, the Pharmacy Corps and the Medical Administrative Corps are abolished. The functions of the Medical Service Corps created by this Act shall include the duties and functions heretofore prescribed for the Pharmacy Corps and the Medical Administrative Corps.

(b) Effective the date of enactment of this Act, persons holding temporary appointments or commissions in the Army of the United States permanently assigned or detailed to the Medical Administrative Corps, the Pharmacy Corps, or the Sanitary Corps shall be automatically transferred and permanently assigned or detailed, as the case may be, to the Medical Service Corps, established by this Act, in the same temporary grade and rank held by them at such time.

* * *

If competent scientists are to be induced to enter the Armed Services, it is essential that they be given rank and prestige commensurate with their training and abilities. If they are to be used effectively, it is essential that their activities be directed by men with similar backgrounds and points of view. In these respects the Navy Bill, S. 334, is at least a step in the right direction. On the other hand, it is difficult to imagine how the Army Bill, S. 504, could possibly have been worse. It provides for initial commissions one grade lower than for physicians in the Medical Corps. The name of the corps emphasizes its subordinate position in the Medical Department. No educational or other qualification is prescribed. The scientists are grouped with optometrists, pharmacists, administrators, and others of the most diverse backgrounds and points of view. The chief of the corps, responsible for the establishment of policies governing personnel, research, liaison, etc., might belong to any one of these groups.

One defect in both bills is the failure to provide a means for at least initially commissioning senior scientific personnel at a rank commensurate with their abilities. It is this type of individual which is now most sorely needed. As written, the bills provide high-rank commissions only for those with previous military service. The Army Bill provides for rank no higher than that of major.

Another serious omission in both bills is the lack of provision for a reserve component. This is of especial importance to the civilian scientist, but it is also of great importance to plans of the Armed Services for the utilization of scientists in time of war. The Services have neglected to realize that a commissioned reserve scientific component will assist in stimulating and maintaining the interests of at least a small group of civilian scientists in Service problems.

Consideration should be given to including in both bills provisions for an integrated enlisted component in order to provide the necessary technicians and to avoid the constant loss and replacement of highly trained enlisted personnel which affected scientific programs so seriously during the war.

Lest individuals in the physical sciences feel that this is a problem solely for biological scientists, it should be pointed out that it is conceivable that similar legislation may be introduced to establish similar groups in other branches of the Armed Services. In addition, it is entirely possible that the attitude reflected in the Army Bill may be extended to the physical sciences. It is important, therefore, that *all* branches of science attempt to correct this situation in its incipiency.

These bills, together with the imminence of unification of the Armed Forces and the partial recognition of the importance of the scientist as evidenced by the prominence of the Research and Development Board, bring forward the question of the establishment of an over-all Science Corps in the Armed Services. Conceivably, such a corps could consist of Physical Science and Biological Science Divisions, have cognizance of all research and scientific effort in the Armed Forces, and have representation at the highest and all other staff levels. If such a corps is believed to be desirable, efforts should be made by scientists as a whole to establish it in the near future.

The only means of correcting the present legislation is for scientists, especially those who are veterans of World War II, to protest directly to the Committee on Armed Services, U. S. Senate, against the objectionable provisions contained in S. 504.

NEWS
and Notes

The Senate Committee on Labor and Public Welfare has reported favorably on National Science Foundation Bill S. 526, with amendments, as effecting a compromise between S. 525 and the original S. 526 (*Science*, February 21 and March 7). Major amendments to this bill provide that: (1) the Foundation shall consist of 24 members, the President being requested to give due consideration to recommendations from the National Academy of Sciences, Association of Land Grant Colleges and Universities, National Association of State Universities, or other scientific or educational organizations; (2) terms of office shall be staggered so that, following initial establishment of the Foundation, one-quarter of the members are appointed every two years; (3) the Committee for the Division of National Defense shall consist of not less than 12 or more than 36 members, half to be civilians appointed by the Foundation and half, representatives of the armed services, designated in equal numbers by the Secretaries of the principal branches of these services; (4) there shall be an executive committee of not more than 6 members within the Division of National Defense; (5) the Committee for this Division shall advise the Director on security classification matters; (6) no officer or employee of the Foundation shall acquire, retain, or transfer any rights, under patent laws of the U.S. or otherwise, in any invention produced in connection with his assigned activities and directly related to the subject matter thereof; (7) in making contractual or other arrangements for research, attention be given also to aiding institutions, agencies, or organizations which show potentiality for advancing research, as well as encouraging independent research by individuals; (8) funds available to government agencies for scientific or technical research or development may be transferred to the Foundation upon approval of the head of any such agency; and (9) the National Roster shall be transferred to the Foundation.

Discussion of amended S. 526 on the Senate floor is imminent. At the time of debate, Senator Wayne Morse will recommend a further amendment to the effect that a minimum of 25 per cent of all funds (exclusive of those for national defense) shall be distributed on a geographic and population basis among the states, such amounts to be expended only for research activities in tax-supported colleges and universities, including land-grant colleges, and an additional amount of not less than 25 per cent shall be expended in nonprofit organizations.

Five committees have been organized to direct local arrangements for the 114th meeting of the AAAS to be held in Chicago December 26–31, 1947: Finance, Equipment, Reception and Entertainment, Registration, and Publicity. At preliminary meetings held April 7–9, these committees elected officers, prescribed their respective functions, and discussed matters of general policy relating to the organization of the annual meeting.

The Equipment Committee elected R. T. Van Niman, Chicago Technical Societies Council, as its chairman. Members are: G. M. Bench, Chicago Board of Education; Donald Boardman, Wheaton College; J. M. Bradford, George Williams College; Leonard Freese, National College of Education; John Hudson, Loyola University; Weston L. Krogman, University of Chicago; C. Kutrumanos, Elmhurst College; Theodore F. Lindgren, Illinois Institute of Technology; M. C. Lobstein, Chicago Museum of Science and Industry; John R. Millar, Chicago Natural History Museum; John B. Murphy, DePaul University; Charles S. Seevers, Roosevelt College; B. J. Spence, Northwestern University; Eliot C. Williams, Chicago Academy of Sciences; and W. R. Williams, University of Illinois. The Committee's functions include a survey of session rooms, procurement and distribution of projection machines, blackboards, public address systems, signs, and other items of equipment, and the scheduling of projector operators. Because of high rental costs and the exorbitant union wage rate of $11 a session for operators, it was the consensus of this Committee that requests for projection equipment be restricted to cases in which its use is absolutely necessary for clarity of presentation, and that papers supplemented by projections be combined in one or two sessions.

The Reception and Entertainment Committee elected Miss Margaret Scriven, Chicago Historical Society, as its chairman. In arranging the General Reception for members of the AAAS, a women's tea, tours of educational and industrial organizations, and other special functions, Miss Scriven will be assisted by: Bernard J. Babler, DePaul University; Benjamin Burack, Roosevelt College; J. C. Chaderton, University of Illinois; Harold Davis, Northwestern University; Alfred E. Emerson, University of Chicago; Alvin Johnson, Elmhurst College; Robert C. Kintner, Illinois Institute of Technology; Anna P. Kummer, Chicago Academy of Sciences; A. C. Maack, Chicago Technical Societies Council; D. M. MacMaster, Museum of Science and Industry; K. Lucille McCluskey, Saint Xavier College for Women; Karl P. Schmidt, Chicago Natural History Museum; A. H. Steinhaus, George Williams College; and Paul Wright, Wheaton College.

The Registration Committee elected Hans O. Hoeppner, University of Chicago, as its chairman. Dr. Hoeppner at one time supervised the annual convention of the Kiwanis Clubs and is well qualified to direct his Committee in making the physical arrangements for registration. Those serving with him are: Sister Mary Bertha, Saint Xavier College for Women; Angeline Brandt, Wheaton College; Edward M. A. Chandler, Roosevelt College; Earl A. Davis, Jr., Elmhurst College; Clarence E. Deakins, Illinois Institute of Technology; Ralph O. Freeland, Northwestern University; Theodor K. Just, Chicago Natural History Museum; G. L. Schuytema, George Williams College; John M. Spence, University of Illinois; Kathryn J. Stephenson, Chicago Academy of Sciences; James J. Vasa, DePaul University; and Elmer

Wirth, Chicago Technical Societies Council.

The Publicity Committee will staff and equip a press room in the headquarters hotel for press representatives. It will also carry on a local campaign by press and radio to stimulate interest and cooperation among Chicago residents in the AAAS meetings and those of its many affiliated societies. Miss Jeannette Lowrey, University of Chicago, was elected chairman. Members include: Sister Mary del Rey, Saint Xavier College for Women; H. DeBruine, Elmhurst College; J. W. Fuhrer, George Williams College; L. M. Glassner, Chicago Technical Societies Council; J. L. Leedy, Wheaton College; Paul S. Martin, Chicago Natural History Museum; William V. Morgenstern, University of Chicago; Carl C. Pfeiffer, University of Illinois; Arthur J. Schaefer, DePaul University; Edward Stromberg, Northwestern University; Frank E. Wheeler, Illinois Institute of Technology; and Eliot C. Williams, Jr., Chicago Academy of Sciences.

The Finance Committee, under the chairmanship of W. P. Cortelyou, Roosevelt College, will subscribe the funds necessary to meet the expenses incurred by the local committees. Preliminary budget estimates indicate that these expenses will be close to $4,000, exclusive of the contributions of time by more than 70 committee members. Dr. Cortelyou will be assisted by: Sister Stella Maria, Saint Xavier College for Women; Marion Barnes, Wheaton College; John K. Baumgart, Elmhurst College; Anton J. Carlson, University of Chicago; Nathan S. Davis, Chicago Academy of Sciences; F. R. Eckford, George Williams College; Gilbert A. Force, Illinois Institute of Technology; Garfield King, Chicago Historical Society; C. I. Reed, Chicago Technical Societies Council; Colin C. Sanborn, Chicago Natural History Museum; David M. Sharer, DePaul University; Robert K. Summerbell, Northwestern University; and G. E. Wakerling, University of Illinois.

An executive session was held by committee chairmen to discuss the coordination of committee plans and the nomination of a General Chairman. This session was also attended by G. M. Schmeing, Loyola University, and D. M. MacMaster, Museum of Science and Industry. In order that the visiting scientists shall participate in bearing the heavy financial cost of the meeting, it was recommended by this Executive Committee that registration be made mandatory by restricting attendance at the sessions to those who register.

A Nominating Committee was also established to name candidates for general chairman of the Meeting. In the near future the Executive Committee will reconvene at the call of Dr. Hoeppner, who is serving as chairman pro tem, to elect the chairman.

The spontaneous and enthusiastic nature of the discussions at these first meetings of the local committees reflect a spirit of cooperation that will make the 6th Chicago Meeting one of the most memorable in the history of the Association.

About People

Robert P. Sharp, University of Minnesota, has been appointed professor of geomorphology, Division of Geological Sciences, California Institute of Technology, to begin September 1.

Betty Kellett Nadeau has been named research associate and lecturer in geology, Department of Geology and Geological Engineering, Washington University, St. Louis, to conduct research in micropaleontology.

David Krech, assistant professor of psychology, Swarthmore College, has been appointed associate professor of psychology at the University of California, Berkeley, beginning with the academic year 1947–48.

R. G. Sachs, Argonne National Laboratory, has been appointed associate professor of physics at the University of Wisconsin. The appointment becomes effective this coming fall.

Colleges and Universities

Harvard University has announced that its president, James B. Conant, will teach a course in "The Growth of the Experimental Sciences" in the University's new program of General Education next fall. Intended to give nonscientists a background in science, the course will draw on Dr. Conant's book, *On understanding science*, published this spring. This is the second time in Harvard history that a president has taught a course in the modern sense of the word, President Lowell having taught Government I in 1917–18.

At the same time Harvard announced plans for expansion of its new program of General Education to include additional students in all classes and extend the courses on a more mature basis to juniors and seniors. The action follows six months of successful experience with small classes in General Education for freshmen and sophomores.

Through General Education courses in the humanities, physical sciences, and social sciences, aimed to give students a "clear appreciation of the range of human experience and achievement," the University states it is working toward a fundamental change in the elective system of undergraduate instruction. Ultimately it is planned to make the courses required for all undergraduates.

The conviction of President Conant and other officials at Harvard that the elective method did not meet students' needs for a well-rounded program of study resulted in a two-year study by a faculty committee which published a report, "General Education in a Free Society," in 1945. The findings were put into practice on an experimental basis last fall.

Elections

The Los Angeles Society of Internal Medicine, formerly Internal Medicine Section, Los Angeles County Medical Association, has elected Gurth Carpenter, president, Harold J. Hoxie, vice-president, and Edgar F. Mauer, secretary-treasurer, for 1947.

The Royal Astronomical Society has elected the following officers: president—W. M. H. Greaves, Astronomer Royal for Scotland and professor of astronomy, University of Edinburgh; vice-presidents—M. G. Adam, chief assistant, University Observatory, Oxford; M. Davidson; H. H. Plaskett, Savilian professor of astronomy, University of Oxford; and D. H. Sadler, superintendent of the Nautical Almanac; treasurer—Sir Harold Spencer Jones, Astronomer Royal; secretaries—W. H. McCrea, professor of mathematics, University of London; and A. D. Thackeray, assistant director, Solar Physics Observatory, Cambridge; and foreign secretary—F. J. M. Stratton, professor of astrophysics and director of the observatories, University of Cambridge.

TECHNICAL PAPERS

Action of Substituted Salicylaldehydes on Bacteria and Fungi

Lloyd C. Felton and John H. Brewer

Hynson, Westcott & Dunning, Inc., Baltimore, Maryland

While testing the halogenated and/or alkylated saligenins as gram-negative antiseptics, it was thought desirable to test the corresponding salicylaldehydes. Previous to the work which is described in part in this report, these aldehydes had been only superficially investigated for antiseptic activity (*1*). However, as a result of extensive testing carried out on these compounds, particularly on the dibrom derivative, the salicylaldehydes have been shown to possess marked fungicidal and bactericidal activity.

The main problem to be solved before testing the salicylaldehydes was to find a satisfactory means of dissolving these normally insoluble compounds at a suitable pH (*1*) and in a solution which contributed no antibacterial activity. To this end, two methods were developed.

The first involved mixing the free aldehyde with an excess of borax and making an aqueous solution from this mixture. Thus, a stable preparation is obtained at a satisfactory pH and without the irritating properties associated with solutions of the salicylaldehydes alone. The second method made use of the aldehyde-bisulfite compound in conjunction with an equimolecular amount of sodium hydroxide. The solutions thus obtained are apparently fairly stable and nonirritating. However, on long standing, there is complete decomposition to the parent aldehydes. From a bacteriological standpoint there is no apparent difference on a mole-for-mole basis between the two types of preparation.

Antiseptic testing was carried out by serial tube dilutions, using as test organisms the bacteria listed in Table 1. The results indicate that several of the compounds are promising as antiseptics against both gram-positive and gram-negative bacteria. As gram-negative infections do not generally respond well to the usual gram-positive antiseptics, the latter activity is very significant. This will be reported in detail elsewhere.

TABLE 1

Antibacterial Effect of Substituted Salicylaldehydes on Certain Bacteria

Compound	*Staphylococcus* 209		*Shigella shiga*		*Pseudomonas aeruginosa*		*Streptococcus* C-203
	Dilutions of compounds inhibiting 24-hour cultures						
	With serum	Without serum	With serum	Without serum	With serum	Without serum	With serum
Salicylaldehyde	1: 500	1: 2,000	1:2,000	1:2,000	1: 500	1:1,000	1:1,000
5-Chlorsalicylaldehyde	1:4,000	1: 8,000	1:4,000	1:4,000	<1: 500	<1: 500	1:4,000
5-Bromsalicylaldehyde	1:2,000	1: 8,000	1:4,000	1:8,000	<1: 500	1: 500	1:2,000
5-Iodosalicylaldehyde	1:4,000	1: 4,000	1:2,000	1:2,000	<1:2,000	<1:2,000	1:4,000
5-tert-Butylsalicylaldehyde	1:2,000	1:16,000	1:1,000	1:2,000	<1: 500	<1: 500	1:4,000
3,5-Dichlorsalicylaldehyde	1:4,000	1:64,000	1:8,000	1:8,000	1: 500	1: 500	1:8,000
3,5-Dibromsalicylaldehyde*	1:4,000	1:64,000	1:4,000	1:4,000	1: 500	1: 500	1:4,000
3-Chlor-5-bromsalicylaldehyde	1:4,000	1:32,000	1:2,000	1:8,000	1: 500	1: 500	1:4,000
3-Brom-5-tert-butylsalicylaldehyde	1:4,000	1:64,000	1:1,000	1:2,000	<1: 500	<1: 500	1:8,000

* "Dalyde," H. W. & D. brand of dibromsalicylaldehyde.

The salicylaldehydes prepared were also tested for fungistatic activity against *Trichophyton mentagraphytes* #640, a common pathogenic fungus. The method used was that described previously (*2*). From the results shown in Table 2 it will be noted that several of the compounds exhibit marked fungistatic activity against the fungus strain used. In addition, further studies based on tests described by Schamberg and Kolmer (*4*) show that the salicylaldehydes are fungicidal as well as fungistatic against *T. mentagraphytes*.

TABLE 2

Fungistatic Activity of Substituted Salicylaldehydes Against *Trichophyton mentagraphytes* #640

Name	Fungistatic effect in mm. of inhibition Concentration of compound				
	5%	0.5%	0.05%	0.005%	0.0005%
Salicylaldehyde	Comp.*	0	0	0	0
5-Chlorsalicylaldehyde	"	Comp.	2	0	0
5-Bromsalicylaldehyde	"	"	1	0	0
5-Iodosalicylaldehyde	"	"	3	0	0
5-tert-Butylsalicyaldehyde	"	"	0	0	0
3,5-Dichlorsalicylaldehyde	"	"	15	2	0
3,5-Dibromsalicylaldehyde	"	21	11	8	0
3-Chlor-5-bromsalicylaldehyde	"	25	14	2	0
3-Chlor-5-tert-butylsalicylaldehyde	"	Comp.	14	0	0
3-Brom-5-tert-butylsalicylaldehyde	"	35	12	0	0

* Indicates complete inhibition on a 90-mm. cup-plate.

Thus, on the basis of the preliminary experiments reported here, it can be seen that the series of compounds in question shows activity against both fungi and gram-negative and gram-positive bacteria. The preparation of dibromsalicylaldehyde solubilized with borax was singled out for extensive *in vitro* and *in vivo* testing against both bacterial and fungal infections. The reports of these studies will be the subject of subsequent publications by our collaborators (*3*).

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Prediction of Speed of Performance by Muscle Action Potentials[1]

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By the use of a new electronic counting technique a rather remarkable relationship has been found between reaction time to aperiodic stimuli in a monotonous situation and frequency of muscle action potentials (recorded from bipolar electrodes placed above the eyes) during a 6-second interval before the onset of the stimuli.

The task was to respond by pressing a key as quickly as possible when occasional stimuli (simultaneous flash of light and sound of a buzzer) were presented. The subject was comfortably seated in an electrically shielded, sound-reduced darkroom. The schematic diagram (Fig. 1) shows the general relationships between the various electronic amplifying and recording units used in this study.

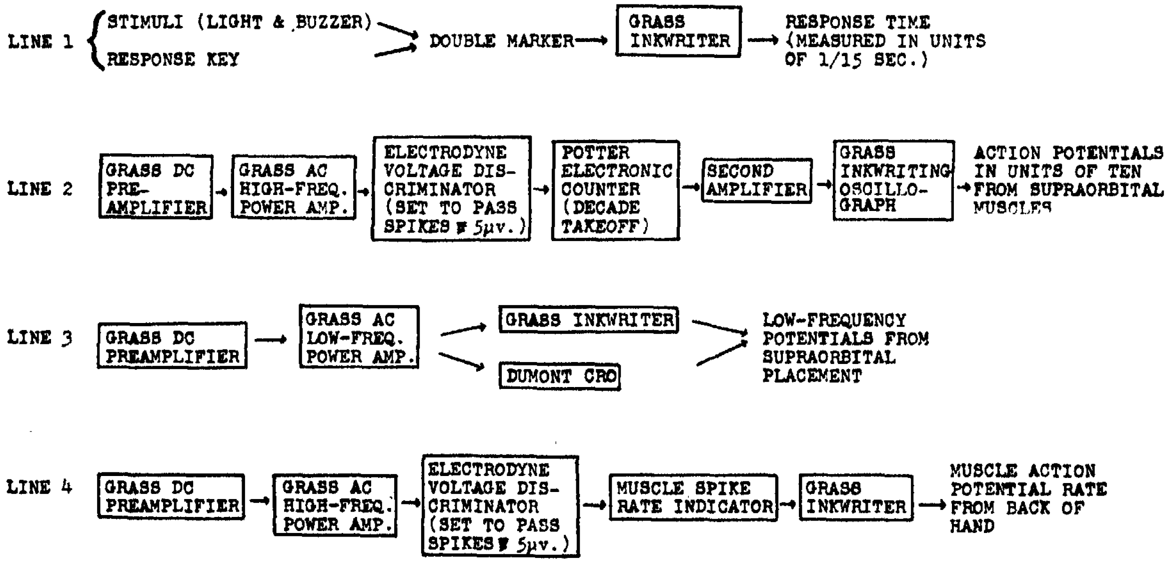
LINE 1
STIMULI (LIGHT & BUZZER)
RESPONSE KEY
DOUBLE MARKER
GRASS INKWRITER
RESPONSE TIME (MEASURED IN UNITS OF 1/15 SEC.)
LINE 2
GRASS DC PRE-AMPLIFIER
GRASS AC HIGH-FREQ. POWER AMP.
ELECTRODYNE VOLTAGE DISCRIMINATOR (SET TO PASS SPIKES ≥ 5µv.)
POTTER ELECTRONIC COUNTER (DECADE TAKEOFF)
SECOND AMPLIFIER
GRASS INKWRITING OSCILLOGRAPH
ACTION POTENTIALS IN UNITS OF TEN FROM SUPRAORBITAL MUSCLES
LINE 3
GRASS DC PREAMPLIFIER
GRASS AC LOW-FREQ. POWER AMP.
GRASS INKWRITER
DUMONT CRO
LOW-FREQUENCY POTENTIALS FROM SUPRAORBITAL PLACEMENT
LINE 4
GRASS DC PREAMPLIFIER
GRASS AC HIGH-FREQ. POWER AMP.
ELECTRODYNE VOLTAGE DISCRIMINATOR (SET TO PASS SPIKES ≥ 5µv.)
MUSCLE SPIKE RATE INDICATOR
GRASS INKWRITER
MUSCLE ACTION POTENTIAL RATE FROM BACK OF HAND

Fig. 1

Presentation of the stimulus, occurrence of the response, frequency of action potentials from surface electrodes placed over the supraorbital muscles, low-frequency potentials from the same supraorbital electrodes, and muscle action potential rate from electrodes on the hand while responding were all simultaneously recorded on a Grass ink-writing oscillograph.

The electrodes were small solder discs attached to the surface of the skin with adhesive tape. Washing the skin with ether and applying a small amount of electrode jelly between skin and electrode served to make a satisfactory low-resistance contact (R = approximately 20,000 ohms). A ground electrode was attached to the subject's cheek.

Fig. 2 shows graphically the gradual transition from sleep to a condition of normal alertness as measured by the reaction time, associated muscle spike frequency, and low-frequency potentials from the supraorbital placement. At the point in the record indicated by the arrow, the experimenter knocked vigorously on the door of the shielded room. The stimulus before the knock had elicited no response, line #2 had shown no muscle activity for the previous 40 seconds, and line #3 showed alpha spindles at low amplitude only for the previous 5 minutes. The knock produced a "startle" reaction, with the immediate resumption of muscle spike activity, low-frequency activity, and a pressing of the response key in the absence of a stimulus. The second stimulus produced a response slower than normal, while the third stimulus, 6 seconds later, produced a normal reaction time. Both responses are shown on line #4 as active contractions of the finger muscles.

It is feasible with this arrangement to achieve considerable versatility in studying a variety of muscle contraction problems under a variety of conditions of effort and work. Some specific data on one of these problems—the course of events in certain muscles only remotely involved in a long-continued task as the individual approaches a state of boredom and sleepiness—are presented here.

Fig. 3 shows the relationship between frequency of action potentials from electrodes placed over the supraorbital muscles and response time to a combined light and buzzer stimulus. The solid line represents the mean values; the vertical lines, the standard deviation above and below the mean. These data

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[1] This work is supported by Contract N5ori-58 with the Human Engineering Section, Special Devices Center, Office of Naval Research.

were obtained from reading lines #1 and #2, portions of which are shown in Fig. 2.

Two major observations may be made from these data. First, there was a definite and distinct reduction in the number of muscle action potentials as the response time became longer. This was due, we presume, to an increasing boredom, sleepiness, etc. on the part of the subject. Secondly, the absolute variability markedly decreased with decreasing motor efficiency. The slight variation in the level of muscle activity for the last four response-time values and the NR (no-response) category is not as important as it may appear, in view of the fact that the average muscle spike count is about three per second and indicates an almost completely relaxed status of the muscles involved. In the case of the NR category, the subject was asleep, and in most cases the stimulus served to awaken the subject on the first presentation, the response time rapidly approaching normal in subsequent presentations.

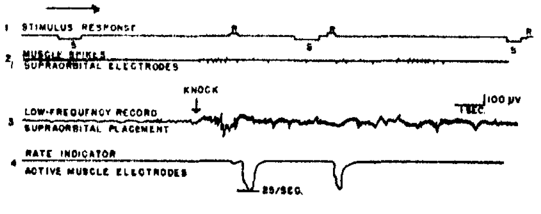

FIG. 2. Tracing of record showing transition from sleep to normal alertness.

Recording line #3 (low-frequency record) in Fig. 2, although originating from the same supraorbital electrodes as line #2 (muscle spikes), exhibited indications of brain activity (alpha waves). There is no doubt that muscle activity in this region of the forehead had a marked effect on the low-frequency record. On the other hand, the usual brain-wave phenomena were also exhibited along with the muscle activity. Sometimes line #2 showed great activity, with little or no activity on line #3, and line #3 showed considerable activity when line #2 was relatively inactive. It was evident that the low-frequency record gave valuable supplementary information, although the information is difficult to quantify. Furthermore, in all instances in which the subject had fallen asleep during a long, monotonous experimental session, both the high- and low-frequency records indicated a very "low-level" activity.

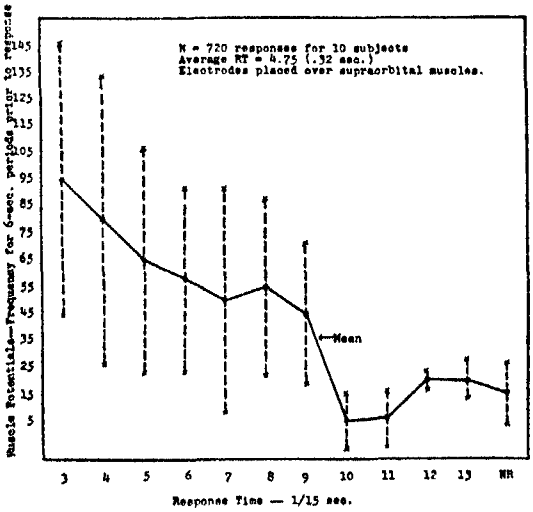

FIG. 3. Relation between response time and muscle spike activity from supraorbital electrode placement.

Line #4 in Fig. 2 indicates the effort put into the response by the subject in terms of muscle spikes per second of time from surface electrodes placed on the back of the hand over muscles involved in pressing the key. As the record shows, more effort was expended in the "startle" response to the knock on the door of the room than to the second stimulus.

It is believed that these techniques may make it possible automatically to warn personnel engaged in monotonous tasks, such as truck driving, before dangerous conditions of inalertness and approaching sleep occur.

Recovery of Western Equine Encephalomyelitis Virus From Wild Bird Mites (*Liponyssus sylviarum*) in Kern County, California[1]

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George Williams Hooper Foundation and School of Public Health, University of California, San Francisco and Berkeley

From the recently deserted nest of a yellow-headed blackbird, *Xanthocephalus xanthocephalus* (Bonaparte), in Kern County, California, approximately 1,000 mites were collected on June 21, 1946. These mites, which have been identified as *Liponyssus sylviarum* (Canestrini and Fanzago), were tested in four pools for the presence of a neurotropic virus. Each pool, containing approximately 250 mites, was ground in 3.0 cc. of 30 per cent rabbit serum-broth, centrifuged for 10 minutes at 3,000 r.p.m., and the supernatant fluid inoculated into 21-day-old mice by the combined intracerebral and intraperitoneal routes. None of the supernatant fluids contained enough bacteria to affect the animals. However, all the mice became ill or died between the third and sixth days after inoculation. Those observed while ill developed convulsions or other signs of encephalitis. Their brains were bacteriologically sterile. After three serial passages in mice were made of the agent isolated from each pool of mites, identification was undertaken. The four infective agents proved to be pathogenic for guinea pigs and hamsters as well as for mice. Three of the four viruses isolated were shown to be Western equine encephalomyelitis, by challenge inoculation of Western equine immune guinea pigs and by neutralization tests in mice with specific Western equine antisera. The fourth virus shows certain antigenic peculiarities; this requires further study, the results of which will be reported at a later date.

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[1] This investigation was carried out in collaboration with the Commission on Virus and Rickettsial Diseases, Army Epidemiological Board, Preventive Medicine Division, Office of the Surgeon General, U. S. Army, aided by a grant from the National Foundation for Infantile Paralysis, Inc., and under contract with the California State Department of Public Health.

The authors are indebted to E. W. Baker, Division of Insect Identification, U. S. National Museum, for confirmation of the mite identifications; Frank Ehrenford and Ronald Reuther, who assisted in the collection of field samples; and Dorothy McAfee and Constance Morshead, who assisted in laboratory tests. Generous assistance and space for a field laboratory were supplied by the Kern County Health Department and General Hospital.

[2] Assigned to the George Williams Hooper Foundation through the California State Department of Public Health by the Communicable Disease Center, U. S. Public Health Service.

From the nest of an English sparrow, *Passer domesticus* (Linn.), which contained two dead nestlings, a collection of 400 mites was made on June 28, 1946. This included two species which have been identified as *L. sylviarum* and *Dermanyssus americanus* Ewing. The collection was divided into two pools of approximately 200 mites each for inoculation into experimental animals. The same techniques as outlined above were used. From one of these pools Western equine encephalomyelitis virus was isolated.

Now, in addition to *D. gallinae* (*7*), at least one other genus of mites (*Liponyssus*) has been found which is naturally infected with the Western equine virus. The fact that three and possibly four isolations were made from one bird's nest incriminates as the source of infection at least one of the birds then or previously occupying the nest. Thus, evidence has been obtained regarding infection of *wild birds*, a *Liponyssus* mite, and possibly a *Dermanyssus* mite of wild birds with the Western equine virus. This evidence is similar to that reported by Sulkin (*7*) with Western equine virus and Smith, *et al.* (*6*) with St. Louis virus in the case of chickens and chicken mites. However, until persistence of infection and transmission by bite under experimental conditions is demonstrated, we prefer to reserve further interpretation of the possible role played by mites. *Culex pipiens* Linn. and *Anopheles freeborni* Aitken have been found naturally infected with Western equine virus (*4*), but their role as vectors has been discredited since experimental transmission could not be demonstrated (*2*). St. Louis virus will persist for some time in several species of anopheline mosquitoes, but transmission has not been effected (*1, 8*). In this laboratory, over a period of six years, thousands of *D. gallinae* have been tested from encephalitis areas outside of California, all with negative results (*3, 5*). In Kern County, an endemic area where surveys have been made for the past four years, *D. gallinea* have not been found in any chicken houses.[3] This suggests that it is not an essential vector or reservoir in one of the outstanding endemic areas.

These matters are emphasized not to indicate that mites are not suspected as vectors, but with the hope of preventing uncritical quotation or interpretation of mite findings.

Addendum: In 1877 Canestrini and Fanzago (*Atti Reale Inst. Veneto Sci. Let. Art.*, Ser. 5, **4**, 124–125) described *L. sylviarum* as *Dermanyssus sylviarum* n. sp. In 1884 Canestrini (*Ibid.*, Ser. 6, **2**, 1659–1660) placed the species in the new genus *Leiognathus* and used the specific name *silviarum*. The latter spelling has been commonly used by workers in acarology, whereas, according to the *International Rules of Zoological Nomenclature*, the original spelling, *sylviarum*, is correct.

L. sylviarum is known as the feather mite, or Northern fowl mite. It is commonly found on a wide range of wild bird species and is a serious pest of chickens in the northern part of the United States. In appearance this mite closely resembles *D. gallinae* (common chicken mite) but differs biologically in that it has a pronounced tendency to remain on its hosts at all times, taking blood meals repeatedly, and even laying its eggs among the feathers where they may hatch. *D. gallinae* usually leaves its host after feeding and deposits its eggs in cracks and crevices. The larval stage of *L. sylviarum* does not take a blood meal, as do the nymphal and adult stages.

Several authors have reported these two species of mites as attacking man and producing a pronounced dermatitis. This has not been our experience, although it has been a common occurrence to have hundreds of specimens crawling on laboratory personnel working with heavily infested bird nests. No bites have been noted.

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Effect of 2,4-D on Bean Progeny Seedlings

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Seedlings of red kidney beans from parents sprayed with 2,4-D during the ripening of pods show a range of 2,4-D symptoms in the juvenile and mature foliage. Virus-like crisp foliage, dwarfing of growth, and serration and fusion of leaflets were noted in some degree in all seedlings. Parent plants were sprayed with 0.5 per cent and higher concentrations of 2,4-D amine salt. All seedlings showed characteristic 2,4-D injury. Unsprayed parents yielded normal seedlings.

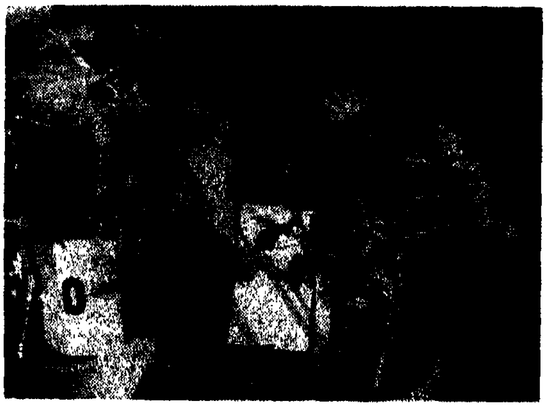

Fig. 1. Seedlings of normal habit from unsprayed parent (0) and those of dwarf habit, abnormal juvenile leaf texture, and fused mature leaf top (1) and of abnormal virus-like symptoms (1, bottom). These seedlings were from parent plant sprayed with 0.5 per cent 2,4-D.

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[3] Unpublished data.

IN THE LABORATORY

Multiple Thermal Analyses

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One of the most useful techniques in the study of clay minerals is differential thermal analysis, a procedure which can be used for both qualitative and semiquantitative analysis of many minerals. In this technique a two-headed thermocouple is employed. One head is inserted in an inert material which does not undergo either exothermic or endothermic reactions through the temperature interval to be studied; the other is placed in the mineral or mixture of minerals under test. With constant heating rate, any thermal reaction in the sample will be recorded as a "peak" or a "valley" in the otherwise straight-line curve, dependent on the nature of the heat change.

Thermal curves have recently been obtained from 6 samples simultaneously on one record sheet. On another sheet, driven by an electric motor synchronized with the multiple record motor, the temperature curve is drawn. The samples are mounted in a cylindrical resistance furnace. The pattern of the sample distribution in the vertical nickel block is shown in Fig. 1. The 6 samples to be tested are loaded in the outer holes, while the three inner holes are used for the inert material, purified alundum. The dotted lines indicate the connections between the two heads of the differential thermocouple. Dots "a" indicate the positions of the temperature-recording thermocouples. The heads of these couples are adjusted to the same height as the differential couples in the samples. The sample and alundum holes are ¼ inch in diameter and ⅜ inch deep; the nickel block, 1⅞ inch in diameter and 1½ inch thick. A round cover of solid nickel, ¼ inch thick, is placed on top of this specimen holder to shield the samples from direct radiation.

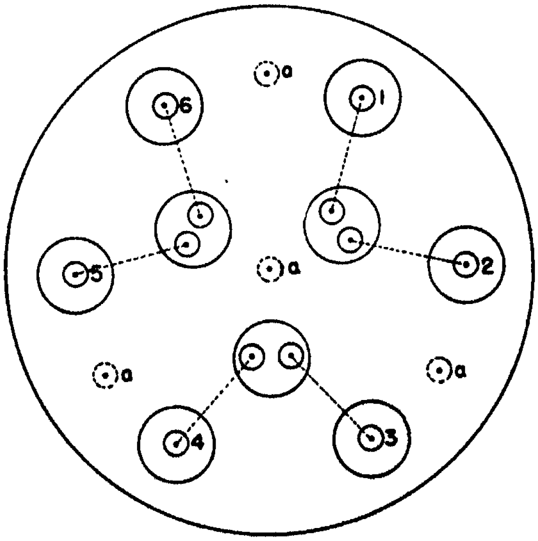

Fig. 1. Arrangement of samples in nickel block.

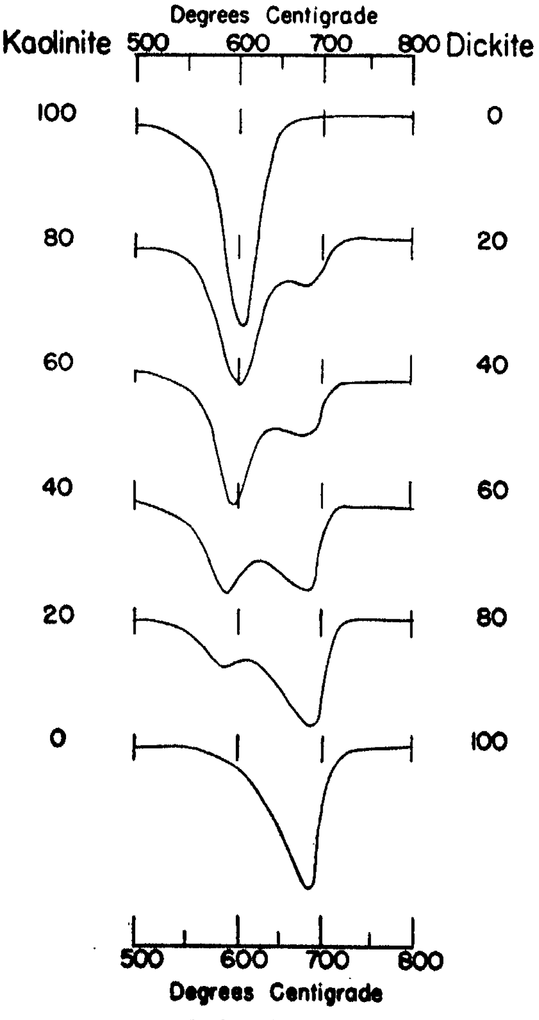

Fig. 2. Kaolinite-dickite mixtures.

The temperature thermocouple actuates a "micromax" recorder which is part of a program controller. A "speedomax," six-point, high-speed, electronic recorder with a maximum range of 3 mv is used to print the differential thermal curves.

Fig. 2 shows in a greatly reduced form a set of curves from one run for artificial mixtures of the clay minerals, kaolinite and dickite. Only the portions of the curves between 500° and 800° C. are shown in this diagram. The vertical coordinate for each curve indicates the relative intensity of endothermic reaction. The amplitude of the peaks is related to the percentage of the mineral present.

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[1] The writers are indebted to Dr. Sterling B. Hendricks, of the Bureau of Plant Industry, U. S. Department of Agriculture, for suggestions concerning the construction of equipment.

Two significant improvements in the technique of thermal analysis are evident with this type of apparatus. First, there is saving in time by running 6 instead of a single specimen. In an 8-hour day, 18 samples can be run conveniently. Second, there are certain inherent advantages in the simultaneous recording of 6 samples.

Discrepancy in Analysis of Penicillin in Blood by the Oxford Cup Method as Revealed by the Paper Disc Technique

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It is well known that low results are obtained when penicillin is assayed in the presence of blood by the Oxford cup procedure. We have found that this is not the case when the filter-paper disc technique is used. Under the same conditions, the latter method gives results close to the theoretical.

In the experiment to be described, three solutions were prepared by adding 0.5 ml. of concentrated penicillin in phosphate buffer to 4.5 ml. of the following blood fractions: defibrinated whole blood, oxalated blood, and serum. In subsequent dilutions for assay purposes, the ratio of the blood protein was maintained at a constant level of 90 per cent by using as diluent 90 per cent blood fraction and 10 per cent phosphate buffer. The resulting solutions were assayed against a standard solution of penicillin in 0.11 M phosphate buffer of pH 7.34. The technique described by de Beer and Sherwood (*2*) was used for the paper disc assays. The Oxford cup assays, performed simultaneously on the same solutions, employed glass cylinders (5.7–5.9 mm. inside diameter and 9.9–10.4 mm. high) as reservoirs. All other details, such as the agar medium, the *Bacillus subtilis* seed, the incubation, etc., were identical for both procedures.

TABLE 1

PERCENTAGE PENICILLIN FOUND BY ASSAY

Blood preparation	Paper disc method	Oxford cup method
Defibrinated rabbit blood	97.6	33.5
Oxalated rabbit blood	92.0	39.0
Rabbit serum	89.5	66.6

The initial concentration of penicillin for each of the blood preparations was *320 units/ml.* Oxalated blood was prepared by adding 2 mg. of $K_2C_2O_4 \cdot H_2O$ to each ml. of blood.

The results of a typical assay are given in Table 1.

It will be observed that in every instance the results obtained by the Oxford cup method were low, whereas the values by the paper disc method were comparatively satisfactory. The slight losses in the latter case possibly may be due to a destructive action of the blood upon the penicillin. Such an action has been demonstrated by Bigger (*1*) and confirmed by us. We have found that blood containing penicillin solutions, when allowed to stand for a week or 10 days at refrigerator temperatures, suffered losses as high as 60 per cent as revealed by the paper disc technique. Thick paper discs under these circumstances appeared to be less reliable than those cut from thin filter paper.

Similar discrepancies between the disc and the cup technique were observed when dog blood was used instead of rabbit blood. E. T. Reese, of the J. T. Baker Chemical Company (personal communication), also has found that the disc method gives higher results than the cup method on samples of fermentation medium, but that the methods are in agreement on samples of commercial penicillin.

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A Simple Method for Studying Friction

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A spring which obeys Hooke's law has one end fastened to a horizontal plane and the other end fastened to a body so that displacement of the body along the plane produces a horizontal restoring force in the spring. When there is sufficient displacement to produce a restoring force of greater magnitude than the maximum static frictional force between the body and the plane, and the displacing force is then removed, the spring will move the body back along the plane. The body will continue in this motion until the kinetic frictional force exerted on the body by the plane absorbs all of the kinetic energy given to the body by the restoring force of the spring.

If the kinetic frictional force above is the only force which absorbs energy while the block is moving under the spring's influence, the time rate at which the energy is absorbed will be the same as that at which the sum of the potential and kinetic energies is decreasing in the system, since this is a nonconservative system. Thus, $f\frac{dx}{dt} = \frac{d}{dt}(\frac{1}{2}mv^2 + V(x))$, where $V(x)$ is the potential energy of the spring and $\frac{1}{2}mv^2$ is the kinetic energy of the body. Since all of the kinetic energy is absorbed by the kinetic frictional force and since the restoring force of the spring is linear, the magnitude of the kinetic frictional force will be equal to the average of the restoring forces acting on the body while it is in motion after one given displacement. (Integrating both sides of the above equation for the interval $x_2 - x_1$, over which the body moves after a given displacement, since the velocity is zero at the beginning and end of the interval, gives $f = \frac{1}{2}(F_1 + F_2)$, where F_1 and F_2 are the restoring forces of the elongations x_1 and x_2 of the spring.)

This offers a very simple classroom method for measuring kinetic friction when a block slides on a horizontal plane. A spring balance is used as the spring. The sliding frictional force may be determined by displacing the block along the plane until the spring-balance force is large enough to slide the block backwards upon removal of the displacing force. A reading of the spring balance should be taken at this point. Another reading is taken after the displacing force is removed and the block has stopped sliding. (The maximum restoring force should not be so great as to give a minimum restoring force of less than zero.) The arithmetical mean of the two corrected spring-balance readings is equal to the magnitude of the average restoring force and hence will be equal to the magnitude of the sliding frictional force. In determining the coefficient of sliding friction where the change in the frictional force for a given change in normal force is used, it is not necessary to correct the spring-balance readings, since the corrections would subtract to zero.

This method may also be applied in studying the friction of a body moving on an inclined plane. In this case, the average spring-balance reading would include the component of the weight of the body along the plane.

Thermostated Cell Compartment for the Beckman Spectrophotometer

Paul H. Bell and C. R. Stryker

American Cyanamid Company, Stamford, Connecticut

The Beckman Spectrophotometer, as furnished by the manufacturer, is quite useful for the study of any rate process involving a spectral change. However, since most mechanism studies depend on quantitative reaction-rate measurements, thermostating of the reacting solutions in the instrument becomes essential.

Preliminary research on penicillin had shown that marked changes of ultraviolet absorption took place during its chemical degradation. These experiments indicated clearly that the acid degradation forming penillic acid from penicillin was quite complicated, with one or more conjugated intermediates existing in the solution during the reactions. Because of the large amount of effort being spent on determining the structure of penillic acid, a careful study of the mechanism of its formation from penicillin was made.[1] The temperature control necessary for this complex study was obtained by the thermostated cell compartment described below.

The construction and outward physical appearance of the Beckman Spectrophotometer should be familiar to anyone interested in this report, and therefore detailed description is not necessary. The compartment described is designed to replace the sample holders furnished with the instrument. The solvent balancing feature of the instrument requires that a solvent cell as well as the sample cell be moved into the light beam. This is accomplished by moving the thermostating jacket containing the cells back and forth inside the light-tight compartment which is rigidly attached to the spectrophotometer.

The actual compartment in a partly dismantled condition is shown in Fig. 1. In Fig. 2, scale drawings are shown, with an accompanying legend giving the essential details of the construction. The main frame, thermostating jacket, pipes, guides, cell holder, and screws are all of brass. (The most important of these are indicated by crosshatching.) Other parts, such as the inside and outside plates forming the dead-air spaces in top, bottom, and ends, plates on both sides, slide handle, and the light-tight sliding door in the top, are constructed from bakelite.

The optical system of the spectrophotometer uses a spherical mirror in an off-axis position to focus the monochromatic light on the exit slit. This arrangement gives a divergent exit beam, the dimensions of which are shown by (1) and (13). The position for the absorption cells was chosen where this beam was nearly square in shape, making it possible to use cells with the same sample thickness but completely blocking the beam with only 0.5–0.75 cc. of solution. The space occupied by the cells (8) is located at one side of the water jacket to keep as small as possible the distance between the cells and the photocell detector. This feature minimizes the errors due to light scattering from the cells and solutions.

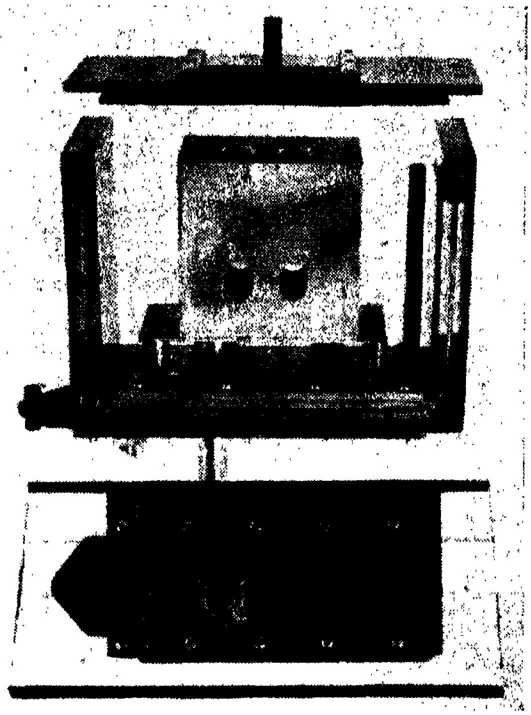

Fig. 1. Thermostated cell compartment with sides removed and the top in an exploded position, and a mirrored view of the bottom.

Since this equipment was designed to be useful several degrees above or below room temperature, certain insulating features were necessary. By the use of multiple walls, the dead-air spaces (5) were created. Also, the compartment was insulated from the spectrophotometer and the phototube compartment by bakelite plates with only small openings for the light beam. If the cell compartment was being maintained at a temperature much below that of the room, the problem of frosting of the absorption cell windows had to be overcome. To do this, space was allowed for desiccant, and drying gas ports (4) were provided. In order to keep the compartment from taking in damp air when the cells were being withdrawn or inserted through (6), the clearance between the movable water jacket and the top was kept as small as possible.

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[1] The results of this work were reported at the Atlantic City meeting of the American Chemical Society, April 8-12, 1946, and will be published shortly.

The water jacket, inside sliding plate (14), and the sliding handle (10) are held together by the liquid tubes (2 and 3). This unit can move within the guides (9), since openings are provided in the brass bottom and the bakelite plate forming the bottom air space, to accommodate the movement of the tubes (2 and 3). The supporting plate (14) and the sliding handle plate (10) cover these slots at all times, thereby maintaining the dead-air space (5) and keeping the entire compartment light tight.

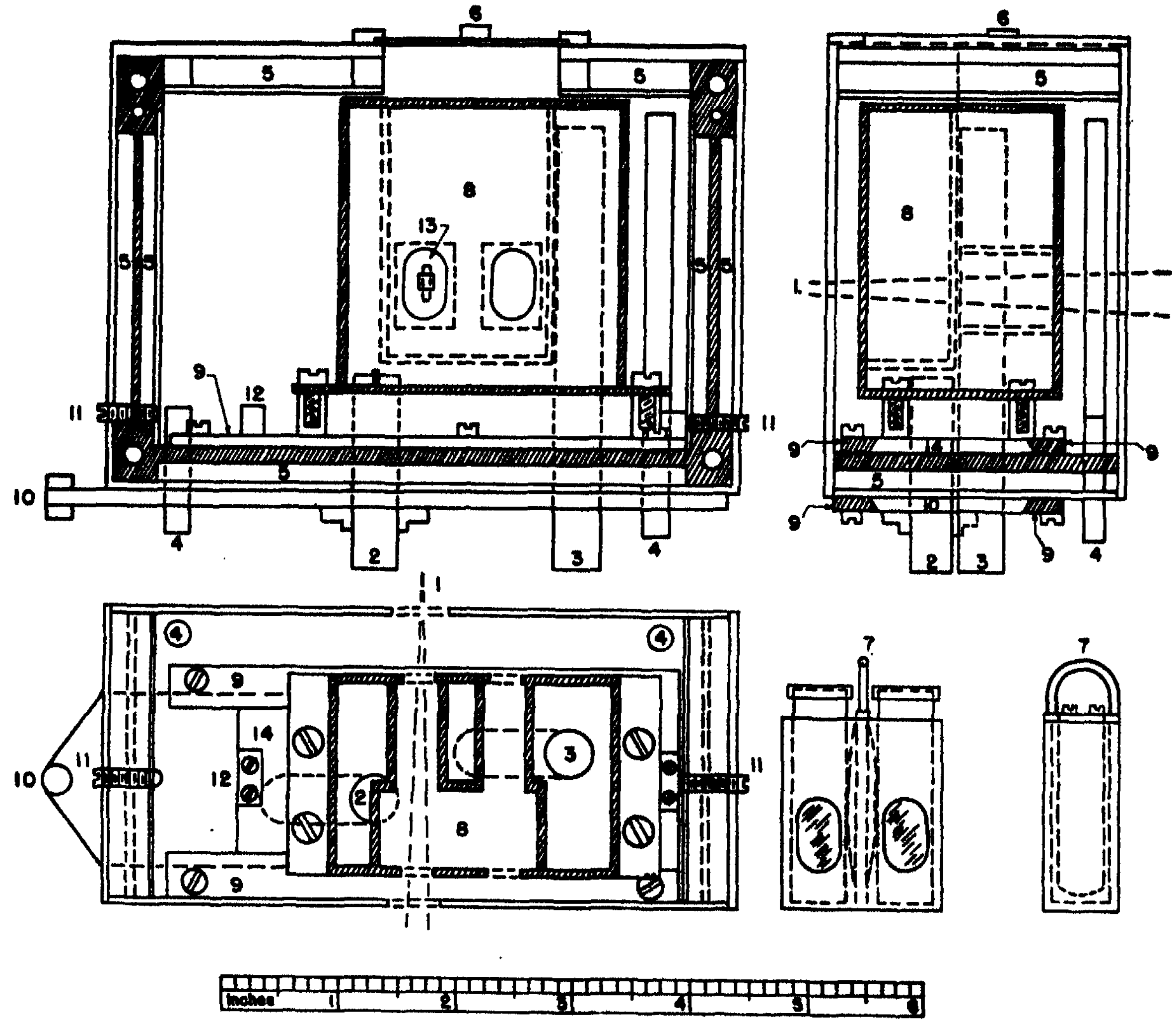

FIG. 2. Scale drawing of thermostated cell compartment.

(1) Light path from spectrophotometer
(2) Thermostating liquid inlet
(3) Thermostating liquid exit
(4) Drying gas ports
(5) Insulating dead-air spaces
(6) Sliding light-tight cover
(7) Cells and cell holder
(8) Space for cell holder in thermostat
(9) Guides for the movable plates carrying the thermostat
(10) Sliding handle
(11) Adjustment screws for limiting horizontal motion
(12) Bumper for adjustment screw
(13) Position and shape of light beam
(14) Sliding supporting plate

Using thermocouples, immersed in the liquid contained in the absorption cells (4 cc. each), temperature measurements were made to test the efficiency of thermostating. The thermostating liquid was supplied by an American Instrument Company Refrigerated Constant Temperature Bath and passed through the compartment at a rate of 1 gallon/minute. Starting with the solutions at room temperature, approximately 10 minutes was necessary to obtain thermal equilibrium. At the highest temperature tested (76°C.), less than a 0.5°C. drop was observed between the bath and solutions in the thermostating compartment. This thermostating arrangement has been tested and used from 5°C. to 76°C. and found to give very satisfactory temperature control.

International Exchanges

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IN THE TEXT OF THE THREE-POWER STATEment on atomic energy, released in November 1945, there are several references to the desirability and necessity of interchanging scientific information. "Scientific literature" is mentioned specifically. This is believed to be the first time on record that the heads of three great governments have jointly advocated the exchange of scientific publications. Other evidence pointing in the direction of growing recognition of the importance of international exchanges is the extensive use of scientific publications by the General Staffs, the unprecedented demands made upon libraries by wartime research, and the regrettable frequency of calls for foreign publications not available anywhere in this country. Mention should also be made of the attention paid to foreign scientific and technical books and journals by the Alien Property Custodian; the careful scrutiny and digesting of enemy documents, still in process; and the distribution of information from these sources to American industry. It seems obvious that, as Vannevar Bush has commented, "adequate technical libraries are an indispensable tool for research workers."

Support for the idea of international exchanges has come also from another source, the United Nations Educational, Scientific, and Cultural Organization. The UNESCO constitution states as one of the primary functions of that body the maintenance, increase, and diffusion of knowledge "by encouraging cooperation among the nations in all branches of intellectual activity, including the international exchange of persons active in the fields of education, science and culture and the exchange of publications, objects of artistic and scientific interest and other materials of information; [and] by initiating methods of international cooperation calculated to give the people of all countries access to the printed and published materials produced by any of them."

The role to be played by the United States in any plan for international intellectual cooperation will undoubtedly be of first importance because of the advanced state of scientific progress here, our efficiently organized libraries and other cultural and educational institutions, wide experience in the international exchange field, well-developed bibliographical services, and like factors. It is certain that a large measure of national initiative will be essential to the success of any such comprehensive program as UNESCO is contemplating.

The interchange of literature, information, and personnel on a world-wide scale is, of course, a problem with numerous ramifications. It involves, for example, exchange of publications between institutions; exchanges of official documents among governments; commercial exchanges; national bibliography; indexing and abstracting organs; cooperative acquisition agreements among libraries; reproduction of research materials; copyright, tariff, and postal regulations; interlibrary loans; traveling exhibitions; and reconstruction of war-devastated libraries. Certain major aspects of these and related problems will be reviewed briefly here.

EXCHANGES BETWEEN INSTITUTIONS

International exchanges of publications between universities, learned societies, and other agencies are chiefly concerned with institutional publications, particularly current serials, on a title-for-title basis. Comparatively few American libraries—probably not more than 100—have benefited substantially from foreign exchanges. The most active exchange programs are carried on by large universities having strong presses associated with them and willing to allot sufficient funds and material for the purpose. When properly supported, exchange relationships with organizations abroad have proven extremely profitable. Several difficulties, however, are still unresolved, even though the exchange movement in the United States began at least three generations ago. No list of foreign publications available for exchange is in print, and, consequently, arrangements must be negotiated directly between libraries, frequently on a hit-or-miss basis. One result is many gaps and much unevenness in library collections. Another problem arises in connection with the Smithsonian Institution's International Exchange Service, an agency subsidized by Congress to transmit foreign exchanges (*Science*, August 9, 1946). As the system is now organized, individual libraries ship materials to the Smithsonian in Washington. From there the materials are forwarded to a foreign national bureau, which then transmits them to the receiving library. Actual delivery of publications under this plan is often excessively slow, perhaps requiring as much as six months time, because shipments are allowed to accumulate and are then sent by slow ocean freight. Such delays may be quite serious in the natural sciences, for example, if

This article is based in part on proceedings of a Conference on International Exchanges, sponsored by the American Library Association, held at Princeton University, November 25-26, 1946.

research on a particular problem is under way simultaneously in two or more countries. The solution would appear to be in the use of air freight, or in sending microfilm copies by air post, for the most urgently needed publications. To deal with the entire problem of exchanges between institutions, possibly a central coordinating agency is needed in each nation to expedite arrangements, to secure more complete coverage, and to stimulate the forming of exchange relationships.

Incidentally, the needs of scholars and scientists in the United States require the resumption of normal cultural, educational, and scientific relations with former enemy countries as promptly as possible. Many American universities, learned societies, and research libraries are holding shipments of their publications, especially for Germany and Japan, awaiting removal of wartime restrictions on transmission of such materials. At the same time, they wish to receive scholarly publications from functioning institutions in the ex-enemy nations. A high proportion of such material is of no military significance whatsoever, but does have a direct relationship to the activities of American scholars and research workers. At present, publications from Germany and Japan can be obtained, if at all, only through military channels and with great difficulty. There seems to be no alternative to opening normal peacetime communications except sending special missions on the War Department's authorization, and this procedure is expensive, slow, and cumbersome.

EXCHANGE OF GOVERNMENT PUBLICATIONS

Because of the expense involved, lack of bibliographical information, restrictions on distribution, limited demand, and space requirements, only a limited number of American libraries have been able to develop adequate collections of publications of foreign governments. Nevertheless, research workers are intensifying their interest in foreign documents—an interest which received its greatest impetus during the war years and is increasing with the continued emphasis on international organizations of all sorts. The Library of Congress is designated by Congress as the official recipient of foreign documents coming, by treaty or executive agreements, from other governments in exchange for our own Federal publications. A single copy in the national capital falls short, however, of meeting the demand. The need might be met, on the other hand, by the designation of certain strategically located centers in the United States to receive all important foreign documentary publications in exchange for official American publications to be sent to depositories abroad. Countries not wanting additional sets of publications of our Federal Government could be offered state documents or nongovernmental books and journals. In view of its strategic position, the Library of Congress is the logical agency to serve as a clearinghouse and coordinator for an expanded scheme of distribution of foreign official material.

NATIONAL BIBLIOGRAPHY

One of the major obstacles to international exchange is lack of information concerning the publishing output of various countries. Few nations maintain adequate records of book production. The gaps are conspicuous for virtually all Latin America, the Far East, and most of the minor countries of the world. Retrospectively, the situation is less satisfactory than that for current publishing. In the case of Italian printing, for example, national bibliography is almost a blank from 1500 to 1850, a 350-year period. Even in countries which have long been active bibliographically, the record is incomplete, e.g. 18th-century English printing and American printing for the first three quarters of the 19th Century. The United States is certainly now the leading nation in bibliographical matters, yet none of the three principal media for listing current imprints—the *Cumulative Book Index*, the *Publishers' Weekly*, or the Copyright Office's *Catalogue of Copyright Entries*—is more than a partial record of American publishing. Omitted are nearly all government documents, periodicals, newspapers, many private press imprints, a majority of pamphlets, and a considerable percentage of noncommercial and institutional material.

To achieve reasonably complete coverage of world book production is a Gargantuan bibliographical task. It calls for the full cooperation of UNESCO, the International Federation of Documentation, national governments, national libraries, library associations, pertinent commercial organizations, and any other agencies having an interest in finding a satisfactory solution. In countries with limited resources and little bibliographical background the stimulus must come from the outside.

The bibliographical treatment of periodicals calls for special comment. Particularly needed is a world list of current periodicals, noting such information as inclusion in abstracting and indexing services, availability on exchange, subjects covered, and all essential bibliographical details. The lack of a work of this kind is keenly felt during the present period when many periodicals abroad have discontinued, new journals have started, and national directories of periodicals have suspended publication. Negotiations for exchanges and purchases can hardly begin when the very existence of a journal is not definitely known. During the war the Library of Congress undertook the compilation of a union list of American holdings of scientific and technical periodicals issued in the Axis and Axis-controlled areas. This tool proved of frequent research value in the war effort and was especially useful because of its location feature. The list should now be expanded to serve as a guide to libraries trying to fill gaps in their files and as a basis for a republication program.

INDEXING AND ABSTRACTING

Closely related to the whole periodical situation is the question of abstracts and indexes. In this field there are serious problems of overlapping, with abstracting and indexing services in different countries, or even the same country, covering the same materials. On the other hand, contrasting with this unnecessary and expensive duplication of labor there are numerous valuable journals and broad areas (the social sciences, for instance) now omitted from any indexing medium. Careful consideration should be given to determining what kinds of activities—national and international—will reveal most satisfactorily the results of research in all countries. The disappearance of the German indexing and abstracting publications left a substantial void, and the United States, with its vast resources, has an excellent opportunity to step into the breach. Such complex problems must be solved, however, as finding qualified abstractors to deal with scientific and other literature, in a variety of languages, throughout the world; deciding whether indexes and abstracts should be complete or selective; obtaining funds, amounting to hundreds of thousands of dollars annually, for preparation and publication; and, finally, overcoming the difficulties of getting access to journals of all countries. As a first step, to help define the size of the undertaking, it would be desirable to have a world bibliography of indexing and abstracting periodicals, giving under each title a list of publications indexed or abstracted. Such a tool would serve as a guide for the establishment of new indexing and abstracting organs and for reduction of duplication of effort.

REPRODUCTION OF RESEARCH MATERIALS

The problem of reproduction of research materials divides itself into three parts: the need, the technical processes, and the potential uses. Because of destruction of research materials during the war years, the limited editions in which books and journals were issued in countries at war, and the increasing demands for materials on the part of libraries, scholars, and research workers, it has long been apparent that the available supply will fall short of requirements. The dilemma can be met satisfactorily only by an extensive program of reproduction by printing, photo-offset, microfilming, microprinting, or other methods. Here, too, international cooperation will be essential. It will be far more economical, for example, for a publication to be reproduced only once, to supply the demand in all countries, than to have each nation repeat the process separately. This would seem to call for the establishment of a central agency, or agencies, to coordinate the reissue of journals and other materials needed by American and foreign libraries and to determine what titles are in sufficient demand internationally to produce in the original size, in reduced facsimile, or by microfilm. Because of gaps in information, it might be necessary to develop, to some extent, bibliographies of publications of the war years before items which should be reproduced can be identified.

Also a part of the same field is international cooperation in the improvement of methods of reproducing library materials. Much experimentation and research are needed, as, for example, in microfilm and microprint techniques and mechanical indexing systems, before a reasonable degree of perfection is reached. As one instance, is the Rider "microcard" proposal capable of being developed to a point where it will be a feasible tool for the large-scale reproduction of research materials? Or, again, what are the comparative costs of reproduction, by the several processes now in common use, of materials of different lengths, types, and in varying numbers of copies? Closely related to the problem is a definite need for adoption of an international code of standards for technical reproduction. Interchanges of material are now handicapped by variations in practices and work quality.

A third phase concerns use. Studies are needed of the use of microreproductions for interlibrary loans, for exchanges between institutions, and to determine how satisfactorily reproductions serve the purposes of the scholar and student. In view of the hazards of transportation, extensive lending of original materials between countries is not practicable, and we must look toward increasing utilization of microfilm or other photographic reproductions to replace originals. The idea of international interlibrary loans is, of course, appealing and idealistic. In happier days it apparently worked well in western Europe, but, from a realistic point of view, there is considerable risk now of damage or loss in sending valuable materials across oceans and other great distances, and other means must be found. Uniformity in international interlibrary loan practices might be achieved by the establishment of a national clearinghouse in each country. The Library of Congress would be the natural center for the United States and could make decisions on whether original publications, films, or photostats should be sent.

COORDINATION OF BOOK ACQUISITIONS

From a practical point of view, it is impossible for even the largest libraries to hold more than a fraction of the world's literature. Originally under the sponsorship of the Library of Congress, and more recently taken over by the Association of Research Libraries, a far-reaching plan is being developed for cooperative coverage of foreign publications by American libraries. The aim, in brief, would be accomplished by having participating institutions, each of which would agree to specialize in one or more given divisions of knowledge, acquire at least one copy of every book of potential research value published anywhere in the world. The 45 institutional members of the Association of Research Libraries, supplemented perhaps by an equal number of nonmember libraries, have the financial and other resources necessary to put this program into effect, and there is every probability that rapid progress will be made with it. The mechanics of the program are still to be developed, but purchasing methods will need to be coordinated for economy and speed. The usual pattern of checking national bibliographies, making selections, and ordering individual items from various dealers is not applicable to mass purchasing. Instead of each library negotiating separate contracts, it is probable that one or more responsible central agencies will be set up in each country to select and ship material to cooperating libraries.

As a corollary to the American plan, similar arrangements are even more necessary abroad. In view of the devastation they have suffered and the acute problems they face in restoring their book resources, European libraries should work out acquisition agreements among themselves. It is important for these libraries to obtain a wide coverage of research materials, even if only in a limited number of copies, and this can best be achieved on a coordinated basis. If understandings of the nature indicated could be reached in the areas receiving aid from agencies in the United States, the reconstruction of foreign research libraries would be greatly facilitated.

RECONSTRUCTION OF FOREIGN LIBRARIES

Many libraries in war areas suffered devastation ranging up to complete destruction. Library associations, individual libraries, learned societies, foundations, and relief organizations have performed notable service in aiding war-damaged libraries. The American Book Center, a cooperative agency set up in the Library of Congress for this purpose (*Science*, August 2, 1946), has distributed hundreds of thousands of volumes to libraries abroad, and its activities are continuing. The Inter-Allied Book Centre in London is performing a similar function. Appeals continue to be received, however, and needs have been met only partially. It has been suggested by several persons closely in touch with the situation that the aim should be reconstruction rather than rehabilitation of libraries. This means, in some instances, placing materials where they would be most useful rather than attempting to restore the prewar status. The proposed policy would be to determine what institutions should be strengthened and then to concentrate in them any resources that could be provided. Preferential treatment would be given those libraries that suffered heavily in the war only if their restoration would prove of greatest benefit to the nations in which they are located. It is suggested further that in most devastated countries there are established agencies which could advise on most effective placement of materials.

COPYRIGHT, TARIFF, AND POSTAL REGULATIONS

Without question, three of the chief impediments to the free flow of ideas across national boundaries are copyright, tariff restrictions, and postal regulations. The question of copyright, for example, immediately comes to the fore in considering the reproduction of books, journals, and other research materials, even though the original editions may be completely inadequate to meet the demands. In 1935 a "gentlemen's agreement" was reached between the Joint Committee on Materials for Research and the National Association of Book Publishers, whereby libraries are permitted, extralegally, to make reproductions for research purposes. No such principle of fair use, or rule of reason, has ever been incorporated in the copyright law, even though library and publishing interests are not in conflict. The present law handicaps American libraries when they are called upon to microfilm single copies of American books for the use of foreign scholars. The War Department is reported to have met with some success in persuading authors to waive their royalty rights on translations to be used in the occupied countries in order to spread the results of American scholarship of the past few years.

By increasing prices, tariffs restrict the distribution of publications from one nation to another, further limiting scholars' access to the world's knowledge. One such instance is our own Treasury Department's requirement that consular invoices be presented for import shipments of library printed materials. Postal regulations also serve as a deterrent to the general distribution of published materials across national borders. A possible solution is adoption of an international book post system, to reduce postage and expedite transit.

It is quite apparent that no more important or perplexing problem faces UNESCO, libraries, learned societies, and other interested organizations than the removal of these barriers to the free flow of informational materials.

TRANSLATIONS

Both the State and War Departments have successful translation programs for overseas use, and these projects have turned out to be of great value in informing foreign peoples about the United States and in making widely available the works of American scholars and other writers. In our cultural relations with other nations there is a need for translations of both popular and technical literature. Also needed is a comprehensive international record of printed translations. For this purpose, a revival of the *Index Translationum*, published annually from 1932 to 1940, or a similar compilation would be useful. It has been suggested further that machinery should be established through which publishers might organize, possibly under the sponsorship of UNESCO, to exchange translation rights. Such an agency would aid in determining what works should be translated and would facilitate settlement of copyright and other problems.

EXHIBITS

A direct and effective method of informing world scholarship of the results of research everywhere would be traveling exhibitions of publications. It would be practicable, for example, to select several hundred of the most significant European publications of a particular year and to circulate the collection for exhibition purposes to the principal research centers of the United States. A similar group of American works could be sent to Europe, Latin America, and elsewhere. Possibly the larger libraries, public and academic, could devote a certain portion of their display facilities to such exhibits continuously. Apart from the value of traveling exhibits for bringing foreign books to the attention of scholars and informing the libraries' general clientele, the collections would be useful also in guiding library buying and helping to fill in gaps of important books that might otherwise be overlooked.

INTERCHANGE OF PERSONNEL

The principle of international exchange of students is well established. International travel by college and university professors on sabbatical leaves is also traditional. Further interchanges of this character should be encouraged, because of their favorable effect on relations between scholars of different nations. In addition, ways should be found to facilitate interchange of specialists in various fields, from one country to another, to aid in the study and solution of particular problems.

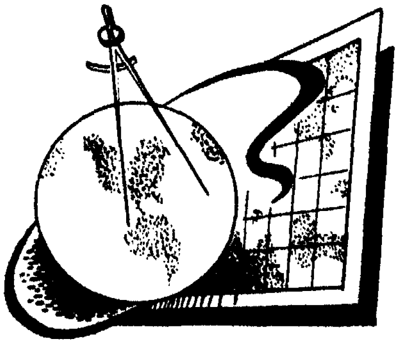
Specifically in relation to libraries, the American information libraries, established abroad, principally under the State Department's direction, during and since the war, have served as excellent training grounds for American librarians, as well as introducing foreign peoples to one of the most democratic of American institutions, the free public library. All the available evidence indicates that these libraries have contributed greatly to the spread of American culture and to a sympathetic appreciation of the United States in foreign lands.

The State Department has also strengthened the cultural relations program by bringing foreign librarians to the United States. Experience has shown, however, that librarians who wish to take advantage of this opportunity should be carefully screened, that they should spend an orientation period of visiting or study in this country before beginning work, and that consideration should be given to the type of work they are to do after returning home. The lack of training agencies for librarians in other countries emphasizes the strategic place occupied by American library schools.

Before further expansion, a thorough study is desirable of both the needs and the geographical areas that might be served by the personnel exchange program and the mechanics of the program.

The foregoing discussion outlines some of the principal features of international exchanges, broadly interpreted, as they relate to libraries, educational institutions, and cultural organizations in general. It is appropriate that the United States should assume leadership in the field. Our own cultural productions were not severely curtailed by the war; our financial and personnel resources are strong; and our libraries and scholars are ready to absorb and use the publications of all countries.

The free interchange of cultural, scientific, and educational information is unquestionably one of the most critical needs of the world today. Society's progress depends upon the extent to which scholars and scientists have unrestricted access to all sources of information. Likewise, international understanding requires that the cultural records of every nation be fully available to all other nations. Finally, intelligent and informed world opinion must be based upon the wide dissemination of educational materials. These are our stakes in efforts to perfect the machinery for international exchanges.



The Army Medical Library

Richard Hood
Army Medical Library, Washington, D. C.

ON THE SOUTH SIDE OF THE MALL IN Washington, D. C., at the corner of 7th Street and Independence Avenue, next to the Smithsonian Institution, stands an old, red brick building which houses such portions of the Army Medical Library and the Army Institute of Pathology as can be accommodated within its walls (Fig. 1). Since 1836 the Army Medical Library, formerly known as the Surgeon General's Library, has grown from a small collection of books to one of the greatest collections of medical literature in the world. It has grown from a small reference library to a great national research library, known throughout the world both for the size and completeness of its collection and for the printed catalogue of that collection, the *Index-Catalogue*. A famous American physician, the late William H. Welch, once said that the Library and its *Index-Catalogue* were one of America's great contributions to medicine.

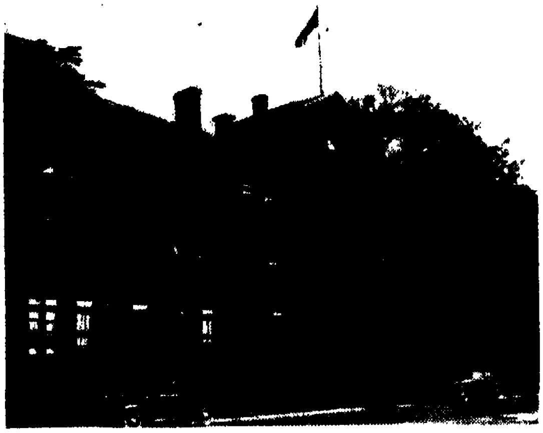


FIG. 1. Present Army Medical Library building, Washington, D. C.

This phenomenal growth was almost entirely the result of the vision and efforts of one man, John Shaw Billings, who came to Washington in 1865 to become an assistant to Surg. Gen. Joseph K. Barnes. Dr. Billings seems to have had the ideal personality for the work ahead. He was a man of affairs; he thought and organized far ahead, on broad lines and in many directions, as his output of 171 publications in the course of half a century bears witness. As a bibliographer, he has been compared with Albrecht von Haller of the 18th Century. He also achieved eminence as a vital and medical statistician, serving actively in preparing the reports of the 10th (1880) and 11th (1890) censuses of the United States. In addition, he was often called on for advice on public health matters and the planning of hospitals.

Almost at once Dr. Billings perceived that the accommodations for a library in the Surgeon General's Office were woefully inadequate, that there was a great need for an analytical catalogue of world medical literature, and that to complete such a catalogue a very extensive collection of medical literature must be available in one building. The next 30 years of his life were devoted to the accomplishment of these tasks.

A letter from him to the secretary of the Medical Society of the County of New York, dated February 3, 1880, gives some figures on the extent of the collection at the time of his arrival. In this he wrote: "When the Library came under my charge in the fall of 1865, it contained, as shown by a catalogue made at the time, about 1800 volumes."

In 1868 the sum of $80,000, remaining from Civil War hospital funds, was made available to Dr. Billings, and he began his great work of collecting and cataloging medical literature. At the time of his departure in 1895, the collection included 310,000 items (117,000 volumes and 193,000 pamphlets).

Through the years the Library's collection has become so large and so well known to the medical profession that its services extend far beyond the Medical Department of the Army. Many related subject fields, such as dentistry, nursing, and veterinary medicine, are represented. The Library also contains a great number of the earliest printed books, pamphlets, and periodicals, including over 500 incunabula.

The collection of early manuscripts from European and Oriental sources and the extensive collection of rare 16th- and 17th-century medical works is of particular interest. A collection of theses published at the University of Paris, considered the most complete in existence, receives constant use. There is also a medical art collection of some 12,000 items, with references to more than 50,000 portraits and illustrations.

The Document Section is attempting to assemble as complete a selection as possible of official health publications of all countries so that vital statistics may be available for any region. Dr. Billings' recognition of the value of statistics had led to an early start of this phase of the collection. The addition in 1922 of a large vital statistics collection of the Prudential Life Insurance Company enhanced the value of these holdings.

Today, under the general directive that "the Library's collections shall contain the medical literature of the world, regardless of language, form, or date of publication," the Acquisition Division shapes its policies to acquire such items as a new medical periodical published in Leningrad, weekly vital statistics from Mozambique, materials on opthalmology from Egypt, on public health in China, and on tuberculosis in Russia. In all, over 67,000 pieces including books and serials were added to the collections in 1946.

Current medical literature and publications unavailable during the war are being received in increasing quantities. Over 4,500 current serial titles in almost every language are regularly recorded. Through the Library of Congress Cooperative Acquisition Program and the increased acquisition activities of the Library itself during the past two years, it will be possible to provide almost complete coverage of postwar German medical publications and probably 80 per cent of all German medical publications of the war years.

In addition to this global coverage of current medical literature, the Library works constantly to fill any gaps in the basic collection. This continuing enrichment of the collection contributes to the steady growth of the Library's reputation as the finest source of materials for medical history. In all, the Library owns over 1,000,000 items, of which at least 500,000 are bound volumes. There are some 17,500 files of periodical titles.

The servicing of this vast accumulation of medical information is the function of the Library's Reference Division. This service supplies medical publications to the Armed Services, local physicians, institutions, and libraries throughout the country. With these exceptions, the Army Medical Library does not lend books directly to individuals; such loans must be secured through local libraries. To fill requests, large numbers of books are sent out each year on interlibrary loan for a two-week period with renewal privileges. As a service to the research worker, selected bibliographies, either brief or extensive, and covering a wide range of subject matter, are compiled in the Reference Division. Telephone inquiries and letters of great variety are received constantly and are answered as promptly as possible.

Since December 1940 the Army Medical Library has been providing a photoduplication and microfilm service on a global basis in the interest of medical research. This is designed primarily to make available to the personnel of the Medical Department and the medical profession at large the literature of the Library's collections. During World War II millions of pages of microfilmed articles were supplied to the Armed Services and other research agencies. By agreement with the Office of Technical Services, Department of Commerce, the Library is a depository for captured German and Japanese documents on medical subjects, which are available through this photoduplication service. The service is now generally available to civilian physicians, institutions, and research workers on a cost basis. The charges are nominal. Material so filmed is, of course, not to be used for reproduction without permission of the copyright owner.

The *Index-Catalogue*, a publication which plays a fundamental role in medical research as a subject bibliography and which has become the foundation for medical library service both here and abroad, is a contribution which owes its origin to the vision and energy of John Shaw Billings. In 1876, nine years after assuming charge of the Library, Dr. Billings realized another one of his cherished ambitions with the publication of the "*Specimen Fasciculus*", which was to serve as a pattern for the *Index-Catalogue*. Established by an Act of Congress in 1879, the *Index-Catalogue* is a medicobibliographical survey carried out uninterruptedly by the U. S. Government. The 56 volumes printed to date list 3,282,405 references, 2,796,435 of which are arranged under subjects. The present volume covers the letter M of the Fourth Series. The number of references revealed by both the printed and the manuscript *Index-Catalogue* amounts to almost 5,000,000, all of which are available in the Army Medical Library. The printed edition is found in numerous public and medical libraries and in many cases is used as an index to their own collections.

After the assassination of President Lincoln in 1865, the Library was set up in Ford's Theater on 10th Street, where it remained until Dr. Billings' plans for a new building were realized in 1887. In that year the collection was installed in the building at 7th and B Streets (now Independence Avenue).

By the time Dr. Billings left the Library in 1895 to become director of the New York Public Library, two men selected by him were already carrying forward his work. Fielding Garrison, who retired in 1930 with the rank of Colonel after nearly 40 years of service to the Library, was editor of the *Index-Catalogue*. Robert Fletcher, another Billings appointee, served as editor of the *Index Medicus*, which had been started in 1876. In 1927 this publication merged with the *Quarterly Cumulative Index* of the American Medical Association, becoming the *Quarterly Cumulative Index Medicus*.

From 1895 to 1936, 12 Medical Corps officers served for various periods as librarians. Garrison had this to say of Billings' successors in office:

> The official management and administration of the great library, the selection and purchase of its books, the selection of material for indexing, the enlargement and improvement of its resources, passed into the hands of the Army medical officers who succeeded Billings. As the cantors of the Thomasschule at Leipzig, the successors of Bach, had to be men learned in counterpoint, worthy followers of the great seventeenth century music master, so these Army surgeons have been men specially selected for their scientific and literary attainments. Huntington, one of the collaborators of the Medical and

Surgical History of the War of the Rebellion; Merrill, distinguished by his work in ornithology; Walter Reed, a pupil of Welch and discoverer of the causal nexus and mode of transmission of yellow fever; and Walter D. McCaw, who specialized in tropical medicine and added greatly to the unique historical collections of the Library, have all been imbued with the spirit of enthusiasm and the interest in the literary side of medicine which Billings brought into his work.

In 1936 Col. Harold W. Jones became the librarian. Col. Jones served for the next 9 years, including the war period—an important one in the Library's history. The year 1936 also marked the first 100 years of the Library's existence. The centennial was celebrated by a gathering representative of the medical profession and the Army on November 16 of that year. Greetings received from governments and institutions throughout the world bore witness to the position of leadership in its field which the Library had achieved. An article in the January 1937 issue of *The Military Surgeon* describes the gathering which met to do honor on this occasion as "an assemblage of guests, noted in bibliography and medicine and library science, as is seldom beheld."

In the years which followed, particularly those immediately preceding the war period, many changes were made which led to an expansion of the Library's services. Interlibrary loans and reference services were increased, and through the introduction of photoduplication it became possible to provide a world-wide medical information service.

Another Library publication is the *Current List of Medical Literature,* started as a private enterprise in 1941 by Atherton Seidell under the sponsorship of the Medical Library Association. In September 1945, its value having been amply demonstrated, it was taken over as an intraservice publication by the War Department. Published weekly by the Army Medical Library, it is designed primarily to serve the individual engaged in medical research by enabling him to glance each week at the contents of journals in his field and find each month, through the subject index, articles published elsewhere on the subjects in which he is interested. It is also designed to be an interim aid to the librarian between appearances of other indexes of more permanent value. The subject headings used are those of the *Quarterly Cumulative Index Medicus,* to which the readers may refer for necessary cross references. The *Current List* is available to personnel and installations of the Medical Corps and Federal agencies on request addressed to the Commandant of the Library.

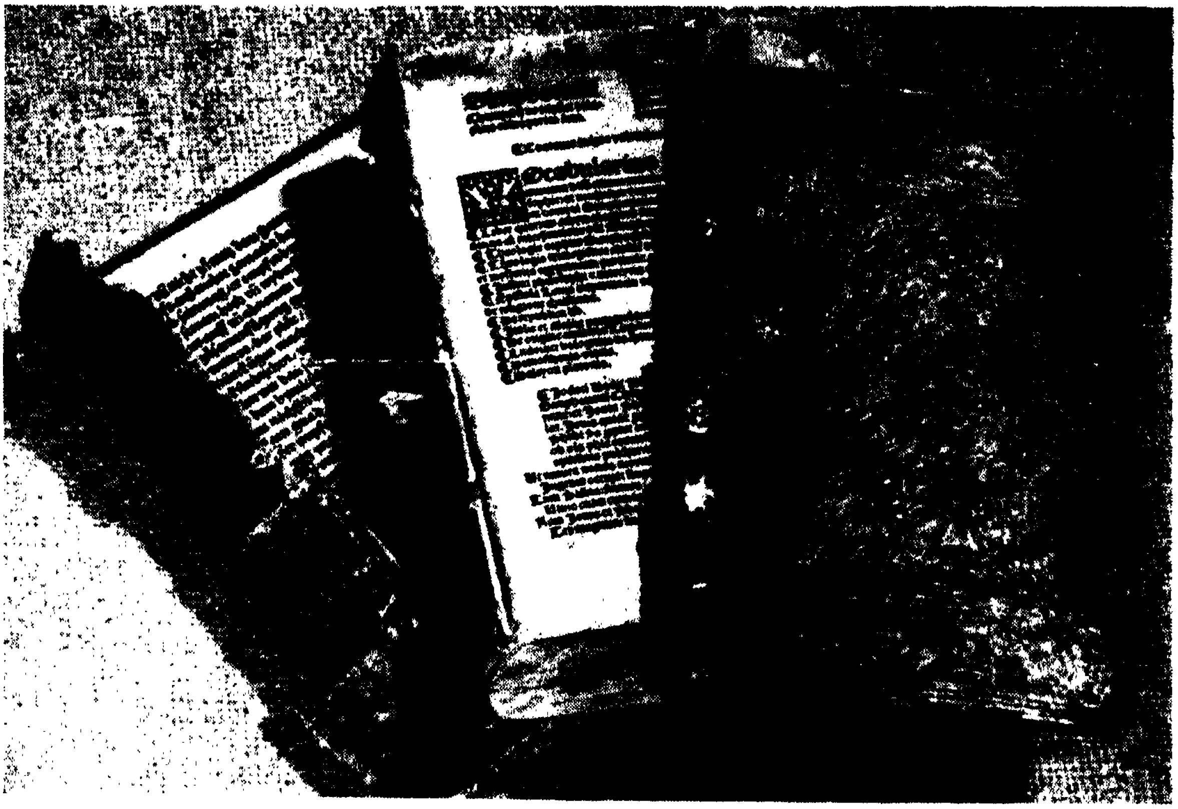


FIG. 2. Champier, *De triplici disiplina,* 1508, before restoration.

Overcrowding, as well as lack of air-conditioning, had taken an irreplaceable toll among the older volumes of the collection through the years. The History of Medicine Division of the Army Medical Library was established in Cleveland in the summer of 1942 to receive and care for a part of the Library's collection which it seemed desirable to place out of probable bombing range and for which there was no longer room in Washington. This included nearly all the Library's books printed before 1801 and much of the noncurrent material in the medical documents and vital statistics collection. A program of repair and rehabilitation of this valuable material has been conducted in this Division (Figs. 2 and 3).

The Library, relying as it did on the printed *Index-Catalogue*, has never had a conventional card catalog of its holdings. In 1944–46 an inventory was made on cards as a preliminary to a complete card catalog. In March 1946 permanent descriptive cataloging of the collections was begun.

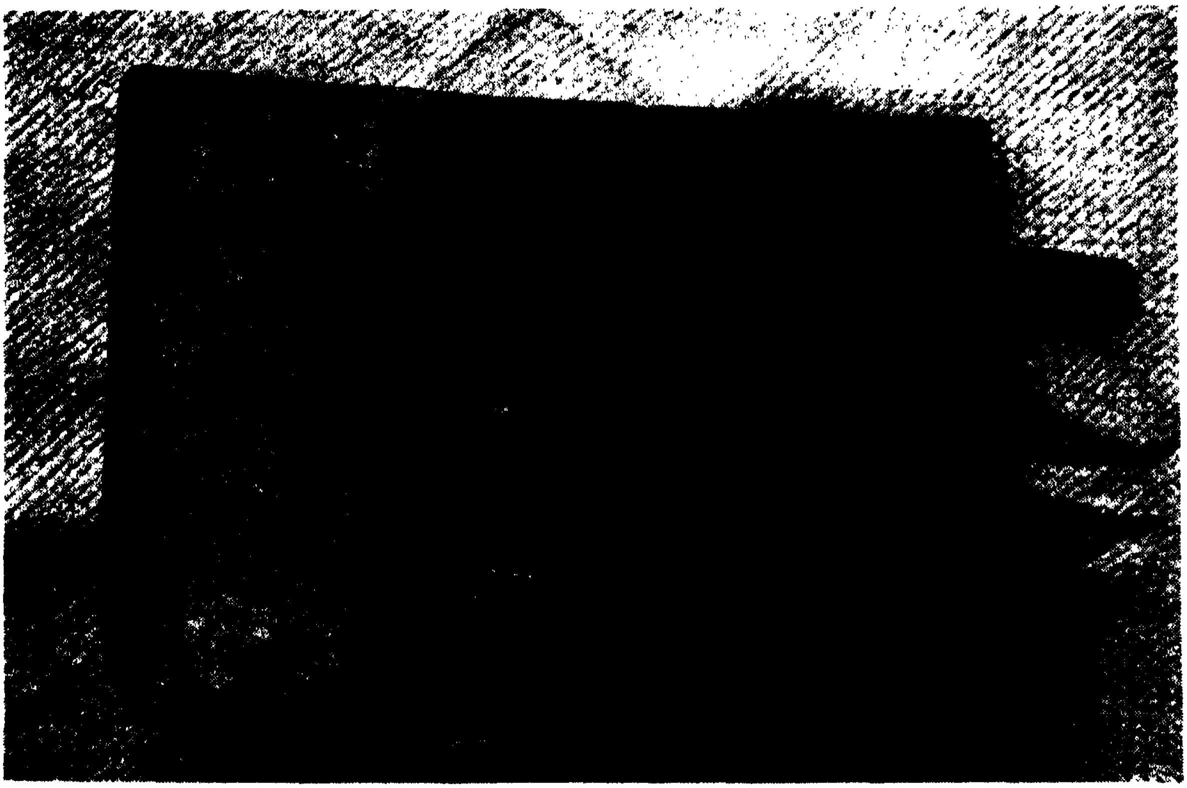


Fig. 3. Champier, *De triplici diciplina*, 1508, after restoration.

There has been no classification subject groupings other than alphabetical arrangements under broad subject groupings. This deficiency, which had resulted in great handicaps to public service, was recognized early in the war. As there was no existing classification adequate for the collection, a new classification for medical literature was prepared by a committee of advisers. In October 1946 this new classification was applied for the first time to books currently received.

The cataloging and classifying of the million titles in the Library will be a stupendous task; no other major research library has undertaken such an extensive reorganization. Upon completion of the work, which will require 10–15 years, the Library will be able to provide finger-tip control over the medical literature in its possession.

Early in 1943 a committee of leading civilian authorities, sponsored by the American Library Association and financed by the Rockefeller Foundation, conducted an intensive survey of the Library and its activities and presented a series of recommendations of a sufficiently long-range character to offer a reorganization suited to future needs. Most pressing among these was the need for a new building to replace the present cramped quarters, occupied by the Library in Washington since 1887. The committee also stressed the importance of building up a professional staff with a modern library organization through which it could function. Since 1943 the staff has been increased from 58 to 128. Through its professional training and abilities it is a credit to a great institution.

The recommendation of the Survey Committee that a new building was an absolute necessity has yet to become an accomplished fact. In 1940 the sum of $130,000 was appropriated for plans. After extensive consultations with the librarian and an advisory board of medical officers, blueprints and artists' drawings were made by the architects, Eggers and Higgins of New York, who spent approximately a year in developing the general plans (Fig. 4). The advent of World War II resulted in postponement of all activity leading toward the immediate erection of a new building. However, in anticipation of eventual action which will provide for the essential needs of the Library, further study has been given to the original drawings. The Library looks forward to the time when a building can be secured which will not only be adequate for present needs but which will anticipate the growth of the collection. The location has been selected, adjoining the Library of Congress on Capitol Hill, where the resources of the Library will be accessible to scholars from all parts of the world.

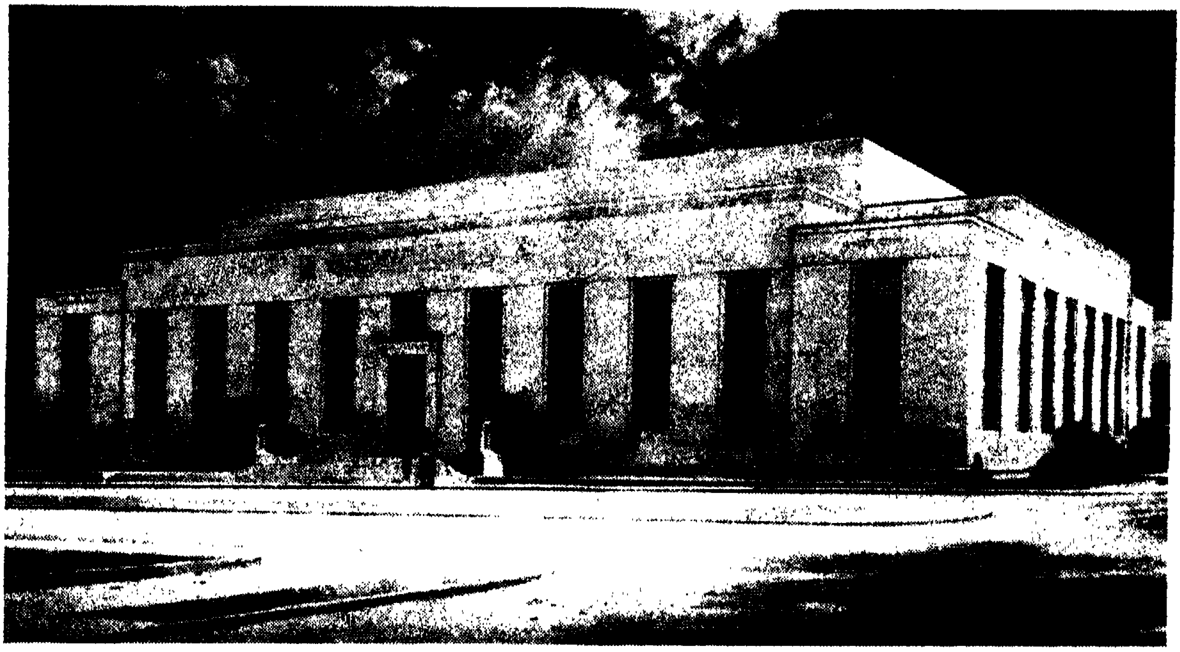
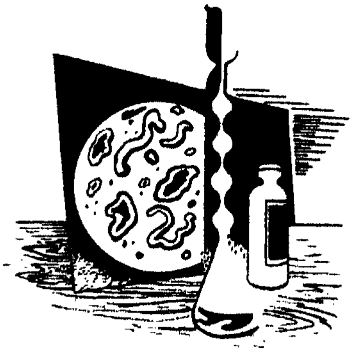


FIG. 4. Proposed Army Medical Library building (architects' drawing).

The Association of Honorary Consultants to the Army Medical Library, an organization which is an outgrowth of an advisory board of outstanding physicians and librarians appointed by Surg. Gen. Patterson in 1931, acts as an advisory body to the Surgeon General on library matters. This Association, the current president of which is John Fulton, professor of physiology at Yale University, is most active in support of the Library.

Through a close working arrangement with the Library of Congress and other Federal research libraries in Washington, the Army Medical Library is able to offer almost unlimited resources in its field. This great medical research library must continue to build and interpret its collection in support of medical progress.



NEWS
and Notes

Plans for a new library at Massachusetts Institute of Technology have been announced by President Karl T. Compton. The structure, to be known as the Charles Hayden Memorial Library, is made possible by a gift of $2,200,000 from the Charles Hayden Foundation, one of the largest single gifts ever received by the Institute.

According to President Compton, the Library will serve a dual purpose. Not only will it be the nucleus of the departmental libraries, thus providing the most useful possible collection of advanced research and teaching material in science, architecture, and engineering, but it will also serve to develop in the students an interest in the humanities and other fields not specifically covered in the M.I.T. curriculum. In line with this objective it is planned to house in the Library the departments in the social sciences and the humanities. Another important part of the Library will be an audiovisual center, in which will be available all sorts of recorded sound and visual devices such as motion-picture film. M.I.T.'s large collection of recorded music will also be housed in this modern center which will, in addition, provide a variety of facilities for instruction in modern languages and public speaking.

The Library will also serve as a graphic arts center and will contain adequate space for exhibits of arts and crafts. There will be a special map room, funds for which have already been provided by a group of alumni, and space will be provided for some of the Institute's special museum collections.

The Corporations' Visiting Committee on the Library, the Director of Libraries, John E. Burchard, the Librarian, William N. Seaver, the present library staff, the Faculty Committee on the Library, the architects, and many others have played a role in formulating plans for this great library. Under a grant from the Rockefeller Foundation the Institute itself has participated in an interuniversity project dealing with library construction. In his annual report President Compton states: "We have good reason to believe that in this projected library we are setting a new standard in university library housing and that the entire program reflects the judgment and foresight of the most experienced and forward-looking people in the library field."

About People

Glenn T. Seaborg, University of California, was the fifth speaker in the Wayne University chemical lecture series Monday evening, March 24. Dr. Seaborg, co-discoverer of plutonium and the transuranic elements, americium and curium, is a member of the 9-man general advisory committee appointed by President Truman to assist the Atomic Energy Commission (*Science*, December 20, 1946).

Raymond J. Seeger has been appointed chief physicist in charge of the Mechanics Division of the Research Department, the Naval Ordnance Laboratory, White Oak, Maryland, has announced. Principal facilities of the Division, engaged primarily in research in fluid dynamics, are supersonic wind tunnels which the Joint Chiefs of Staff transferred from the former Aerodynamics-Ballistics Research Institute at Kochelsee, Germany, to the Naval Ordnance Laboratory. The tunnels will be used partially for research in fundamental gas dynamics, including work in hypersonic flow. Special facilities provide for hydrodynamics research in water entry, initial trajectory, and underwater motion problems. Precision-firing ranges are planned for free-flight observations on aerodynamic models.

Dr. Seeger was research consultant in theoretical physics, Bureau of Ordnance, Navy Department, while on war leave from George Washington University's Department of Physics.

Stephen P. Timoshenko, professor emeritus of theoretical and applied mechanics, Stanford University, is en route to London to deliver a series of lectures at the invitation of the Institution of Mechanical Engineers. Following the lectures, which will be on "Stress Concentrations and Fatigue Failures," Dr. Timoshenko will travel to France, Switzerland, and Germany for consultations on progress in the field of theoretical and applied mechanics, returning to Stanford late in the summer.

A. Sidney Harris, associate professor of physiology at Western Reserve University School of Medicine, has been appointed associate professor of physiology at Baylor University College of Medicine, effective July 1. He will direct a teaching and research divisional unit in the Department of Physiology, embracing cardiovascular physiology and biophysics.

F. C. Henriques, Jr., recently of the Radiation Laboratory, University of California, Berkeley, has joined the staff of Tracerlab, Inc., Boston, Massachusetts. As director of the Radiochemical Division, he is in charge of Tracerlab's rapidly expanding chemical program and will supervise the development of apparatus and techniques for the purification, synthesis, and analysis of radioactive substances.

William H. Peterson, professor of biochemistry, University of Wisconsin, delivered the 7th Harvey Lecture of the current series at the New York Academy of Medicine on April 17. Dr. Peterson spoke on: "Factors Affecting the Kinds and Quantities of Penicillin Produced by Molds."

Visitors to U. S.

G. Malcolm Dyson, scientific director of a group of British chemical manufacturing companies, recently arrived in this country to attend the meeting of the American Chemical Society, at which he spoke on his new notation for organic compounds. Dr. Dyson has recently been made president of an international commission to report on ciphering and related subjects for the International Union of Chemistry.

Arne Tiselius, Uppsala University, chairman of the Swedish Natural Science Research Council, will leave soon for the U. S. to study the application of isotopes to medical and biological research. Per Ohlin and Sten von Friesen, Swedish scientists, will also visit the U. S. for atomic studies in New York, Boston, and Chicago.

D. G. Catcheside, of Trinity College, Cambridge, England, will spend six months in the United States studying the genetics of the Mexican guayule plant. He will join the staff of the Stanford Research Institute, which has undertaken a $150,000 program on natural rubber for the Office of Naval Research. Dr. Catcheside, well known for his studies on the effects of ionizing radiation on hereditary characteristics, is a member of the British Ministry of Labor panel for industrial protection and radiation.

Fellowships

Massachusetts Institute of Technology has announced the availability of a limited number of research assistantships for fundamental research in the organic or physicochemical phases of carbohydrate chemistry. The fellowships have been provided by a grant from the Sugar Research Foundation, Inc., and the investigations must be conducted in the Foundation's laboratory of the Department of Chemistry.

Candidates must be outstanding graduates of accredited colleges and universities who possess a specific interest in the field and who are working toward the Ph.D. degree. They must also meet all requirements for admission to M.I.T.'s Graduate School. The annual stipend to the recipient amounts to $950 for 12 months, exclusive of tuition, which is provided. The appointments are available to candidates for admission at the beginning of the fall term and are ordinarily renewable for the number of years necessary for completion of requirements for the Ph.D., providing that the appointee maintains acceptable standards of performance.

Correspondence should be addressed to the Chairman, Department of Chemistry, Massachusetts Institute of Technology, Cambridge 39, Massachusetts, with specific indication that the candidate is interested in the organic or physicochemical aspects of the field, or both. Application blanks and other information will be forwarded on request.

Grants and Awards

The New York Zoological Society is offering four grants-in-aid of $500 each to qualified scientists for work in the Zoological Park in the Bronx during the summer season of 1947. In addition, appointees will be provided with simple but adequate living quarters. Emphasis will be placed on deviate or abnormal behavior and adjustments of zoological park animals.

The grants will be awarded to individuals who hold at least one advanced degree in the broad fields of the zoological sciences, including medicine, and who are capable of both independent and cooperative research. Special consideration will be given candidates who have advanced training and research experience in comparative psychology or who are medical students and anticipate professional work in psychiatry and/or neurology.

Applications should be made before May 15 to Fairfield Osborn, president of the New York Zoological Society, 630 Fifth Avenue, New York 20, New York.

The Committee on Fellowships and Awards of the American College of Physicians has granted research fellowships in medicine to the following for the year beginning July 1, 1947: Ward S. Fowler, Philadelphia, who will study pathological physiology of certain primary disorders under Julius H. Comroe, Jr., Graduate School of Medicine, University of Pennsylvania; Arnold Livingstone Johnson, Montreal, Canada, who will continue investigation of hemodynamics of congenital heart disease at Children's Memorial Hospital and the Department of Physiology, McGill University, under Alton Goldbloom and H. E. Hoff; Mary Ann Payne, assistant resident in medicine, New York Hospital, for study of hepatorenal factors in regard to shock and hypertension under David P. Barr and Ephraim Shorr; Miriam Mellon Pennoyer, St. Louis, Missouri, for an investigation of adrenal function in newborn and premature infants at St. Louis Children's Hospital under A. F. Hartmann, Washington University School of Medicine; and Philip Franklin Wagley, Baltimore, Maryland, who will study certain mechanisms of hemolysis at Boston City Hospital under William B. Castle and George R. Minot.

First award of a fellowship in this series went to Tom Fite Paine, Jr., Aberdeen, Mississippi (*Science*, January 3, 1947.)

William N. Lacey, professor of chemical engineering, California Institute of Technology, received the Anthony F. Lucas Gold Medal for 1947 at the 75th anniversary banquet of the American Institute of Mining and Metallurgical Engineers, New York City, March 19. Dr. Lacey received the award for "distinguished achievement in directing research in the fundamentals of hydrocarbon behavior and particularly application of these fundamentals to oil and gas reservoirs which have led to greater efficiency in oil and gas production from our oil fields."

Eloise Chute, formerly of the Dartmouth Eye Institute, has been awarded a research fellowship in clinical psychology at the University of Pittsburgh. She will investigate the relationship between the conceptual thinking of deteriorated and senile patients and that of normal subjects of lower mental levels.

The Wildlife Society named "Predation and vertebrate populations," an article by Paul L. Errington, research associate professor of economic zoology, Iowa State College, the outstanding paper in wildlife ecology and management in 1946. The paper appeared in the *Quarterly Review of Biology* for June and September 1946. Dr. Errington, who is a participant in the program of the Iowa Cooperative Wildlife Research Unit, was similarly honored in 1940 (*Science*, April 11, 1941).

Burton E. Livingston, former director of the Laboratory of Plant Physiology, Johns Hopkins University, and recently retired from the Executive Committee of the AAAS, has been awarded the Stephen Hales Prize for 1946, according to an announcement by the American Society of Plant Physiologists in its journal, Plant Physiology.

The journal also reports that Edwin C. Miller, professor emeritus of plant physiology at Kansas State College, has been awarded the honorary Charles Reid Barnes Membership for 1946.

Patricia Dolciani, Cornell University, has been awarded the postdoctoral fellowship of Sigma Delta Epsilon, graduate women's scientific fraternity, for 1947–48. Miss Dolciani, candidate for the Ph.D. degree in mathematics in June 1947, has held the Allen Seymour Olmstead Fellowship at Cornell since 1945. She will continue her research on the integral representation of integers by quadratic forms in three or more variables at the School of Mathematics, Institute for Advanced Study, Princeton.

Howard G. Swann, assistant professor of physiology, University of Texas Medical Branch, Galveston, has received a grant of $10,000 from the Army Research Program to continue studies on aviation physiology which he began during the war at Wright Field Aviation Physiology Laboratories.

The History of Science Society has established a History of Science Prize of $100, to be awarded annually to an undergraduate or first-year graduate student in a U. S. or Canadian college, university, or professional school for the outstanding original paper submitted on some aspect of the history of modern science.

Papers may deal with any of the natural sciences or mathematics, the fields of engineering or agriculture. It is preferred that essay subjects be selected from the period 1600–1915, and that completed essays be transmitted by members of the faculty of the students' institutions. Essays, not to exceed 6,000 words and preferably not more than 3,000 words, will be accepted until October 1.

All communications should be directed to the chairman of the prize committee, Henry Guerlac, professor of history of science, Cornell University, Ithaca, New York.

Colleges and Universities

George D. Stoddard, former vice-president of AAAS, will be installed as president of the University of Illinois May 15–16. Members of the Board of Trustees, faculty, alumni, and invited speakers will participate in ceremonies in Chicago and Urbana-Champaign.

Anton J. Carlson, emeritus professor of physiology, University of Chicago, and past president of AAAS, will speak at a noon luncheon in Chicago, May 15, following morning convocations at the University's Schools of Medicine, Dentistry, Pharmacy, and Nursing.

An afternoon meeting in Chicago will be addressed by President Stoddard; Andrew C. Ivy, vice-president for the University's Chicago professional colleges; and Charles Luckman, alumnus, and president of Lever Brothers. James B. Conant, president of Harvard University and chairman of the executive committee, AAAS, and Omar N. Bradley, U. S. Administrator of Veterans Affairs, will speak at an evening banquet.

At Urbana-Champaign on May 16 President Stoddard will speak at installation exercises in the morning, and the following will later participate in a symposium on higher education: Sir John Orr, Bucksburn, Scotland, member of the British Parliament, and director-general, United Nations Food and Agricultural Organization; Archibald MacLeish, U. S. representative on the executive board of UNESCO; and Robert M. Hutchins, chancellor, University of Chicago.

Stanford University has established an Eye Bank to provide corneal material for eye graft operations at Stanford University Hospital, San Francisco. All qualified eye surgeons on the Pacific Coast will be invited to make use of the Bank, which is being started on gift funds received by the University.

Anthony J. J. Rourke, superintendent of Stanford Hospital, will direct operations of the center. Full information on correct procedure for registration of donors may be obtained from Stanford Eye Bank, 2398 Sacramento Street, San Francisco.

The new 300,000,000-volt betatron being built at the University of Illinois will be 23 feet long, 13 feet high, and 6½ feet thick, compared with corresponding dimensions of 19 inches, 10 inches, and 8 inches for the 2,500,000-volt betatron invented and built at Illinois in 1940.

According to the University, the hollow "donut" vacuum tube in which electrons will be accelerated will be 9 feet in diameter in the new instrument, which will itself weigh more than 400 tons; the first weighed 200 pounds and had a vacuum tube of 8 inches. Electrons will travel 700 miles in the 1947 betatron compared with 60 miles in the 1940 model, and power consumption will be 150 kilowatts compared with 5 kilowatts.

The betatron was invented at Illinois in 1940 by Donald W. Kerst (*Science*, January 3, 1947). The 300,000,000-volt betatron will be the University's fourth. All will be housed in a new laboratory which is nearing completion on the campus.

The Physico-Chemical Institute, University of Uppsala, Sweden, has started construction of a $695,000 cyclotron laboratory financed jointly by industry and the Swedish Government.

The cyclotron, to be completed in 1948, will weigh 640 tons. It is hoped that it will attain energies of 60,000,000 electron volts for nuclei of heavy hydrogen and 120,000,000 volts for ordinary hydrogen nuclei. It will be used for medical and nuclear research by the Institute staff under The Svedberg, and by industry in investigating uses of radiation in production of textile materials and the chemical industry.

The laboratory will form the center of a science quarter to be built with a physical laboratory on one side and a chemical laboratory on the other, according to the Swedish-International Press Bureau, while a biochemical institute and a large institute for inorganic and organic chemistry will be built in the immediate neighborhood.

Another large cyclotron building is in progress at the Nobel Institute, Stockholm, which is under the direction of Manne Siegbahn.

A scroll commemorating the founding meeting of the American Medical Association at the New York University Medical Department in May 1846 was presented to Currier McEwen, dean of the University's College of Medicine, at the recent annual Alumni Day Dinner of the College in New York.

More than 250 alumni doctors of the College of Medicine attended the dinner and witnessed presentation of the scroll, which said: "In commemoration of the assistance and hospitality extended to the National Medical Convention, the first organizational meeting of the American Medical Association, held in May 1846, in the Hall of the Medical Department of the University then located at Broadway and Third Street, New York City, this scroll is presented to the College of Medicine of New York University on the occasion of Alumni Day, February 22, 1947."

The A.M.A. will hold centennial meetings in Atlantic City, June 9–13.

West Virginia University Agricultural Experiment Station announces publication of *Weeds of the world, their digestibility and composition,* by Burch H. Schneider, professor of animal husbandry. The work on which the technical reference book is based was conducted on request of the Committee on Animal Nutrition, National Research Council, with a grant-in-aid from Swift & Company, Chicago.

Northwestern University has developed a new testing machine to test artificial limbs for the country's 20,000 veterans and 65,000 war workers who have had amputations. The machine will make an artificial leg carrying a load of 300 pounds "walk" at the rate of 3,000,000 steps in 10 days, the equivalent of three years of normal wear.

The device was designed by William E. Dunshee, John F. Hopp, and LeRoy Barnes, research associates in mechanical engineering, under a Northwestern program of research in artificial limbs financed by the NRC Committee on Artificial Limbs. Paul E. Klopsteg, director of research, Northwestern University Technological Institute, is director of the NRC Committee.

The fatigue tester is used to study strength and durability of ankle and knee mechanisms, plastic shanks, and plastic cement. In one test of artificial leg fittings used at Army amputation centers a leg completed 7,190,000 steps, or three weeks of continuous high-speed walking, without failing. This is the equivalent of seven years of normal wear.

Preliminary tests indicate that a combination of riveting and bonding—plastic cementing—is the strongest means of connecting joints, and that plastic parts show great strength. No plastic part of any limb has failed to date in the fatigue testing machine.

Summer Programs

The University of Wisconsin in 1948 will discontinue its 16-week summer semester in favor of the regular 8-week session. The full summer session and continual year-round educational program was adopted during the war to speed training programs and was continued as an aid to returned veterans.

The Canadian Mathematical Congress will hold a Summer Seminar at the University of Toronto, August 15-September 14. U. S. mathematicians are invited to attend.

On the research level the Seminar will center on algebra and the theory of numbers. L. J. Mordell, Sadlerian professor of mathematics, Cambridge University, Saunders MacLane, Harvard University, and Paul Dubreil, University of Nancy, on appointment of their respective governments, will give series of lectures. A seminar on algebra under Richard Brauer, University of Toronto, and one on the theory of numbers under Gordon Pall, Illinois Institute of Technology, will integrate work of the general Seminar in these fields.

On the instructional plane there will be courses on the level of the Master's degree on subjects of the Seminar.

It is planned to accommodate mathematicians and their families in one of the residences of the University at a moderate rate. The Seminar fee is $10. Applications should be sent to The Secretariat, Canadian Mathematical Congress, Engineering Building, McGill University, Montreal, Quebec.

Inquiries regarding accommodation should be directed to the secretary of the local committee, G. deB. Robinson, Department of Mathematics, University of Toronto, Toronto, Canada.

Meetings

The Field Conference of Pennsylvania Geologists will be held at Lehigh University, Bethlehem, Pennsylvania, May 30–31 and June 1. Field trips will be held in and near the Lehigh Valley. Information may be obtained from the secretary of the Conference, M. N. Shaffner, Pennsylvania Topographic and Geologic Survey, Harrisburg, or Bradford Willard, head, Department of Geology, Lehigh University, Bethlehem.

The Institute of Food Technologists will meet June 1–4 at the Hotel Statler, Boston, Massachusetts. Among the scheduled features are an evening symposium on "Potential Applications of Colloidal Chemistry and Food Processing," led by Ernst Hauser; sessions on "Food Technology and Its Relation to Management," "Research and Development Administration," "Food Transportation and Storage," and "Food Processing and Sanitation"; seminar sessions on "Frozen Foods" and "Fisheries Technology"; and presentation of the Industry Achievement Award and the Nicholas Appert Medal Award.

Those interested in attending the conference are invited to address Robert J. Gray, Northeast Section, Institute of Food Technologists, % of Dewey and Almy Chemical Company, Cambridge, Massachusetts.

The Meteoritical Society will hold its 10th meeting in connection with the meeting of the Pacific Division of the AAAS in San Diego, California, June 18–19. The afternoon session of June 19 will be a joint session with the Astronomical Society of the Pacific.

Titles and abstracts of papers to be presented at the meeting should be sent to the chairman of the program committee, John A. Russell, Department of Astronomy, University of Southern California, Los Angeles 7, California.

The American Society for the Study of Blood will hold an organizational meeting at the Hotel Claridge, Atlantic City, New Jersey, Sunday, June 8. Information about the new society to promote study of diseases of the blood, blood grouping, and transfusions may be obtained from Alexander S. Wiener, M.D., 64 Rutland Road, Brooklyn 25, New York.

The Ohio Academy of Science will hold its 56th annual meeting at Marietta College, Marietta, Ohio, on May 1–3. Officers of the Academy are: H. H. M. Bowman, University of Toledo, president; W. M. Tidd, Ohio State University, treasurer; and Rush Elliott, Ohio University, secretary.

The New England Section of the American Society of Plant Physiologists will meet at the University of Vermont, Burlington, on May 23–24. Papers will be presented at the Friday afternoon and Saturday morning sessions, and a banquet is scheduled for Friday evening. All plant scientists are invited to make reservations through Dr. James W. Marvin, Department of Botany, University of Vermont.

The American Institute of Electrical Engineers has scheduled the following meetings for the remainder of 1947: Summer General Meeting, Montreal, Quebec, June 9–13; Pacific General Meeting, San Diego, California, August 26–29; Middle Eastern District Meeting, Dayton, Ohio, September 23–25; and Midwest General Meeting, Chicago, Illinois, November 3–7.

Recent Deaths

Sir Joseph Barcroft, 74, British physiologist, died March 21 in London. He was elected a Fellow of the Royal Society in 1910, president of the physiological section of the British Association in 1920, and was Fullerian professor of physiology at the Royal Institution from 1923 to 1926, after which he became professor of physiology at Cambridge.

Marion Savage, 61, a consulting engineer for the General Electric Company, who won the Lamme Gold Medal in 1938 for his work on large, high-speed turbine generators, died April 9 in Walterboro, South Carolina.

Walter Ramsden, 79, senior fellow of Pembroke College, Oxford, and emeritus Johnston professor of biochemistry at the University of Liverpool, died March 26 at Oxford.

Charles A. Cadwell, 76, former professor of mining engineering at Case School of Applied Science and for the last 36 years engaged in research in electricity and metallurgy for the Electric Railway Improvement Company, died March 27 in Cleveland, Ohio.

NRC News

Raymund L. Zwemer has recently been appointed executive secretary of the National Research Council and acting executive secretary of the National Academy of Sciences. For 16 years Dr. Zwemer was active in teaching and research at the College of Physicians and Surgeons, Columbia University, and for the past three years has been with the Department of State as executive director of the Interdepartmental Committee on Scientific and Cultural Cooperation.

The medical advisory committees of the Division of Medical Sciences have held a series of meetings since the first of the year to review problems in medicine, surgery, neuropsychiatry, and other specialized fields. These committees, which serve as a connecting link between the civilian medical profession and the Federal medical departments, are composed largely of outstanding specialists who served in the medical departments of the Army and Navy or contributed in a civilian capacity to work of the armed forces. Among recent problems upon which the committees have advised the Federal medical services are: use of oral penicillin in venereal disease prophylaxis, auditory standards for admission to the U. S. Military Academy, continuation of research on rheumatic fever, use of anesthetic ointments in the eye, and revision of physical standards for the Army and Navy. The latter undertaking will be continued over a period of years, during which currently applied physical and mental standards will be analyzed in the light of latest medical thought and practice. Since future emergencies will probably demand total utilization of man power, studies will be made concerning the use of the physically handicapped in military and civilian jobs. Experience in World War II demonstrated that many physically disqualified individuals can render effective service if properly assigned. In the revised physical standards, provisions will be made whereby physical and mental disabilities will be evaluated in relation to job placement.

A letter from Bruno Schussnig, Austrian phycologist, indicating the conditions under which he must work, has been received by Lewis Hanford Tiffany, Department of Botany, Northwestern University. Excerpts from the letter follow:

"Due to difficult conditions in Austria both for working and for living, I should appreciate an opportunity of continuing my work in some American university. I beg of you to keep my circumstance in mind and to let me know if any opportunity should arise for me to come to America.

"I shall appreciate any publications you and your fellow botanists can send me, for both my laboratory and my library of about 4,000 volumes in Vienna were completely destroyed by the Nazis. With these publications it will be possible for me to continue my researches. I am hoping to complete my 3-volume treatise on the lower plants. The first volume appeared in 1938 and is to be revised. The second volume will treat of the colonization, sexuality and inheritance among the lower plants, and the third will propose a new classification of these plants."

Professor Schussnig's address is Igls bei Innsbruck, Osterreich, Europa.

Williams & Wilkins Company, scientific publishers, Baltimore, Maryland, announce appointment to the editorial staff of F. Kenneth Albrecht, until recently medical adviser to the U. S. Consulate and immigration authorities in Berlin.

Cinchona Products Institute, Inc., New York, celebrated its 10th anniversary in New York, March 10. The Institute has sponsored research on the pharmacology and therapeutics of the cinchona alkaloids, as well as the physiology and genetics of the genus *Cinchona*, grants having been made to Cornell University, Johns Hopkins University, Princeton, Chicago University, University of North Carolina, New York University, as well as to individuals and state departments of health. Robert H. deGreeff and Norman Taylor have been president and director, respectively, since establishment of the Institute.

The Kaiser Wilhelm-Institut für Biologie, formerly of Berlin-Dahlem, is now located at Silikatforschung, Faradayweg, but a new central building will soon be built in Tübingen, in the French zone of Germany. K. Paetau is temporarily in charge at Dahlem, where little remains of the original institute. E. Stein, M. v. Dehn, and J. Hassinger-Huizinga are still at Dahlem.

Institut de Recherches sur le Cancer, Lille, France, wishes to exchange periodicals and reprints with U. S. organizations conducting cancer research. Communications may be directed to J. Driessens, Directeur de l'Institut de Recherches sur le Cancer, Cité Hospitalière, Lille, France.

The John Beard Memorial Foundation, a nonprofit organization to investigate problems requiring correlation of biology, chemistry, and the medical sciences, has been established at 642 Capp Street, San Francisco, California. The research program has begun with studies on metagenesis and the trophoblastic character of cancer.

Preliminary steps to establish a new South Pacific Commission were taken February 6 when representatives of the participating governments of Australia, France, Netherlands, New Zealand, United Kingdom, and the United States met at Canberra. The object of the Commission is to promote international cooperation in the development of economic and social welfare of the peoples of the non-self-governing territories in the South Pacific region. All of the governments administer territories south of the equator and east from, and including, Netherlands New Guinea. The Commission is to be a consultative and advisory body, organized to study, formulate, and recommend measures for improving agriculture, animal husbandry, communications, transportation, fisheries, forestry, industry, labor marketing, production, trade and finance, public works, education, health, housing, and social welfare within the territory designated. Each of the participating governments is to appoint two commissioners, who will be required to hold at least two regular sessions per year.

One of the important instruments of the Commission is a research council, which is to be established as a standing body to advise the Commission. It is expected that a small number of qualified full-time workers to help in economic and social research will be appointed immediately. In these activities, provision is made for participation of the local inhabitants.

The Commission has no organic connection with the United Nations, but expects to cooperate as fully as possible from its temporary headquarters at Sydney, where preliminary arrangements for the establishment will be undertaken jointly by the Australian and New Zealand governments.

An initial budget of 40,000 pounds sterling has been provided, which, after ratification by the cooperating governments, will be increased, with Australia carrying almost one-third of the total budget.

Make Plans for—

New York State Geological Association, 19th field meeting, May 9–10, New York City.

Federation of American Societies for Experimental Biology, May 18–22 Chicago, Illinois.

Medical Library Association, 46th annual meeting, May 27–29, Cleveland, Ohio.

American Medical Association, centennial session, June 9–13, Atlantic City, New Jersey.

Pacific Division, AAAS, 28th annual meeting, June 16–21, San Diego, California.

COMMENTS *by Readers*

As the effectiveness of DDT residual house spraying against *Anopheles albimanus* is a problem of great practical importance for malaria control in the Caribbean area, the work of Stephens and Pratt in Puerto Rico (*Science*, January 10, p. 32) should be examined in the light of the experience with this species in Panamá (*Amer. J. trop. Med.*, 1946, *26*, 383), particularly since Stephens and Pratt have overlooked certain basic considerations.

They report that no reduction of *A. albimanus* occurred, a conclusion based solely on bait and light trap catches. On the basis of the Panamá work, bait trap catches alone are not a valid index of the effectiveness of house spraying. Sharp reductions occur, but persist for only two to six weeks after spraying. This transient effect appears not only in the village but also for some distance around it. *A. albimanus* rests in houses during the night, and counts may be made then. Night catches in treated houses in Panamá show the following prolonged effects: (a) great reduction in numbers of anophelines; (b) reduction in the proportion of engorged anophelines; (c) low 24-hour survival rate for engorged anophelines.

These phenomena, of direct significance in terms of the malaria-transmission potential, occur in close association with the sprayed surfaces, namely, in the houses, and are best measured in houses.

Stephens and Pratt compare their bait and light trap catches of *A. albimanus* with house observations of *A. quadrimaculatus* in Arkansas, and *A. pseudopunctipennis* in Mexico, where marked reductions occurred. This is not a valid comparison. House catches of *A. albimanus* in Panamá show results comparable with those obtained with *A. quadrimaculatus* and *A. pseudopunctipennis.* While it is possible, or indeed quite likely, that the mosquitoes of the Puerto Rican houses were similarly affected, the recorded observations are inadequate to show what happened.

The lower malaria rate reported for the treated Puerto Rican village, after one year, may or may not be significant, but in view of the well-known annual fluctuations of malaria, even in adjacent villages and independent of any control measures, judgment should be suspended. (HAROLD TRAPIDO, *Gorgas Memorial Laboratory, Panamá, Republic de Panamá.*)

Bluhm's suggestion that the excess of male births above the theoretical ratio of 50 per cent can be explained by the lighter mass of androsperms (bearing the Y chromosome) in comparison with gynosperms (bearing the X chromosomes) has been criticized recently by Leonard Walker (*Science*, March 7, p. 262). Without necessarily subscribing to Bluhm's theory, I should like to point out a rather obvious fallacy in Walker's argument.

The entire demonstration hinges on the equation: $\frac{v_y}{v_x} = \frac{106}{100}$, in which Walker assumes that the ratio of the velocities of the androsperms and gynosperms is *equal* to the sex ratio. He offers no evidence to support this assumption, and there is every reason to believe that the relationship is by no means so simple.

It seems obvious that the relative velocity of the two kinds of sperms is not the only factor influencing the sex ratio. Also involved are the distance the sperms have to travel, their starting points, and the numbers of each kind of sperm entering the contest, as well as many other factors. If only one sperm of each sort were involved, it is easy to see how the slower sperm might win out, if the faster one, like the hare, stopped on the way; or, in fact, most likely neither sperm would reach the destination. But with 200,000,000 of each kind of sperm in the race, and with only a single victor, any significant advantage for the androsperms would practically guarantee that the winner would be one of the androsperms. Thus, it seems obvious that the difference in velocities of the two sorts of sperms must be much smaller than assumed by the equation given above, because otherwise only males would be born. (ALEXANDER S. WIENER, *64 Rutland Road, Brooklyn, New York.*)

TECHNICAL PAPERS

The Cytological Effects of Podophyllin

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A recent report by L. S. King and M. Sullivan (*1*) compared the similarity of the effects of podophyllin and colchicine and their use in the treatment of condylomata acuminata. Histological examination revealed an alteration of nuclear pattern and "colchicine figures." A study of the cytological effects of podophyllin was thus suggested. This investigation was made on the meristematic tissue of root tips of *Allium Cepa*, and the preliminary observations are reported here.

The British *Pharmacopeia* recognizes podophyllin as the resin of *Podophyllum*, a mixture of resins obtained from either of two plants, American *Podophyllum* or Indian *Podophyllum*. The *National Formulary* resin is obtained only from the former. The rhizomes of the plant yield from 3 to 10 per cent of resin consisting of podophyllotoxin, $C_{22}H_{22}O_8$, and small amounts of resin glycosides, resenes, starch, gum, etc. The resin is an amorphous powder varying in color from light brown to greenish yellow, turning darker when exposed to temperature exceeding 25° C. or to light. The resin of *Podophyllum* is slightly soluble in ether or chloroform and is soluble in alcohol, with only a slight opalescence. It is slightly soluble in water and gives a light brown color to the solution. This may be due only to the dissolving of the coloring factor, quercitin, found in the resin.

Merck's *Index* reports that the resin contains picropodophyllin, quercitin, podophylloresin, and podophyllotoxin. It is claimed that the latter ingredient is the active principle. The therapeutic and pharmaceutical activity of the drug is due to this principle, but its cytological effects may be due to an entirely different one. Preliminary experiments with saturated aqueous solutions indicate that the cytological effects are due to a substance in solution. Uniform results were achieved, however, using not only saturated solutions but also the filtrates of such solutions and those from which the color had been removed. Further experiments are being conducted to determine just which of the constituents of the resin produce the cytological changes.

Young growing root tips of *Allium Cepa* were immersed in a saturated aqueous solution of podophyllin, and maximal results were produced in two hours. Typical resting stage and prophase figures were observed in smear preparations. Pronounced cytological effects were produced in late prophase, and the spindle mechanism was evidently impaired, since no orientation of the chromosomes on the metaphase plate was observed. The chromosomes were dispersed in the cell. In this respect podophyllin is comparable to colchicine, to which the inhibition of spindle formation is attributed.

Metaphase chromosomes were in the form of typical diplochromosomes; sister chromatids held together at the spindle attachment region, with slightly contracted arms which have become disengaged from the relational coil.

A notable effect brought about through the use of podophyllin is the increase in the number of mitotic figures up to metaphase, and the decrease and, later, complete absence of anaphase and telophase figures.

Podophyllin has properties which make it useful in cytological research. Toxicity to the cell is negligible except in prolonged treatments involving agitated suspensions. The chromosomes disperse in a typical smear to the extent that counts may be made easily. Because of its similarity to colchicine, podophyllin may prove to be valuable in the role played by colchicine in cytological research.

Podophyllin is readily available at pharmaceutical supply houses and may be obtained at approximately $.90 for four ounces.

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The Phosphorescence of Chlorophyll and Some Chlorin Derivatives

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In the course of our studies on the photochemistry of zinc tetraphenylchlorin (*1*), it appeared necessary to postulate a long-lived excited state of the chlorin. In order to determine whether this and similar molecules were capable of existing in such a metastable state, an experiment was designed to observe the phosphorescence which would be admitted when the molecule passed from this metastable excited state back to the ground state. The conditions most favorable for the observation of this phenomenon were established (*3*) and observations made on three compounds: zinc tetraphenylchlorin, copper tetraphenylchlorin, and a purified mixture of chlorophylls *a* and *b*.[1]

The zinc chlorin and the chlorophyll showed phosphorescent bands commencing in the range of 7,800–8,000 A. and extending into the infrared. The lifetime of the phosphorescent state of these two is estimated in the region of 0.2 second. No phosphorescence could be observed for the copper chlorin on the phosphoroscope used, which fact puts an upper limit to the life of a metastable state for this substance at around 10^{-4} second, if such a metastable state exists at all.

Accepting the interpretation that these metastable states are triplet states whose life is prolonged by the triplet-singlet selection rule prohibition (*2*, *3*), the failure of the copper salt to exhibit phosphorescence can be understood as being due to the breakdown of this selection rule by the inhomogeneous magnetic field produced within the molecule by the paramagnetic moment of the copper. This result was also predicted from the experimental observation that the copper chlorin is not at all comparable in photochemical activity with the zinc salt, although the two compounds are otherwise very similar, especially in absorption spectrum (*1*).

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[1] This sample of chlorophyll was kindly supplied to us by Prof. G. Mackinney. Other derivatives of tetraphenylchlorin and tetraphenylporphyrin were also examined, and the results will be reported elsewhere.

The significance of this observation of the phosphorescence of chlorophyll with respect to the mechanism of photosynthesis will be discussed in detail elsewhere.

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Rate of Vaporization of Sulfur

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The rate of vaporization of elemental sulfur at different air temperatures has been studied by various investigators, including Goodwin and Martin (*3*), Tucker (*6*), Liming (*5*), Turrell (*7*), Fouretier and Boullé (*1*), and others. Such information is of particular interest in agriculture because there appears to be a correlation between rate of vaporization, fineness of sulfur particles, and insecticidal and fungicidal effectiveness. Although some of these data have been summarized in recent books (*2*, *4*), it apparently has not been recognized that the rate of vaporization (sublimation) of elemental sulfur is a logarithmic function of temperature.

Experimental data obtained by the observers named above, as determined by several different methods on various kinds of sulfur from widely different sources, are plotted on a semilogarithmic grid in Fig. 1. The linear curves illustrate the logarithmic relations between rate of vaporization and temperature and may be expressed by a logarithmic equation of the form $\log Y = \log a + X \log b$ or in normal form by the equation $Y = ab^X$.

When compared, slopes of the two curves based on relative vaporization rates are not the same nor are the two curve slopes based on absolute vaporization rates. From the magnitude of the deviations of the points from the curves, it may be surmised that sufficient observations have not been made to define the curve slopes critically. The magnitude of the deviations suggests that with sufficient precision in the determinations, or with larger numbers of observations, curves of the same slope might be found for the various sulfurs used. Juxtaposition of the curves based on Liming's relative values and on Tucker's absolute values may be obtained if the two are adjusted to a single absolute observation. Tucker's values seem unreasonably high, however. Also, the composite curve based on the absolute vaporization rates of ground sulfur, as determined by Turrell (*7*) and by Fouretier and Boullé (*1*), nearly parallels the curve based on the relative values found by Goodwin and Martin (*3*). Comparison of the positions of the curves based on absolute rates suggests that sulfur from different sources may vary in the rate of evaporation at a given temperature. Some of the more obvious causes for this appear to be: (*a*) impurities, such as oil; (*b*) differences in particle size; (*c*) form; and (*d*) technique used in making the determination.

The logarithmic characteristics of the vaporization process at different air temperatures suggest that the rate of vaporization of sulfur of varying particle sizes and from various sources may be determined readily, and that recommendations may be formulated for use in warm as well as cool seasons and climates. Adequate pest control, and reduction of loss of agricultural crops as a result of "sulfur burn," may thus be attained by recommending sulfurs having specified evaporation rates.

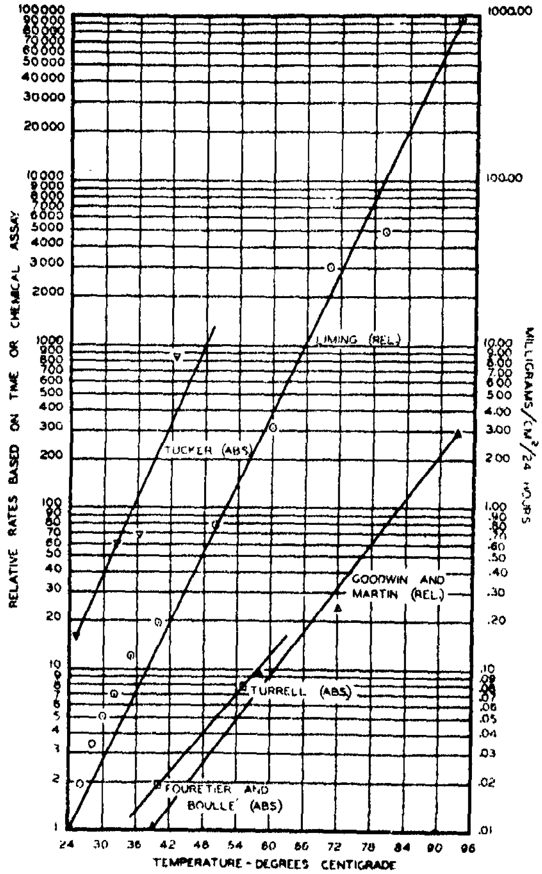

Fig. 1. Relative and absolute rates of volatilization of elemental sulfur, based on data of various observers, showing logarithmic increase of volatilization rate with increase in temperature.

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Effect of Streptomycin on the Metabolism of Certain Mycobacteria

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A nonpathogenic strain of tubercle bacillus, No. 607 of the American Type Culture Collection, rapidly oxidizes benzoic acid. The hydroxybenzoic acids, however, are not oxidized. This confirms Lehmann's observation (*2*) that the oxygen uptake of nonpathogenic strains is not affected by hydroxybenzoic acids, whereas that of pathogenic strains, as previously shown (*1*), is definitely increased by o-hydroxybenzoic acid as well as benzoic acid. The evidence indicates, however, that although the pathogenic strains of tubercle bacillus have an increased oxygen uptake in the presence of benzoic and o-hydroxybenzoic acids, these compounds are not oxidized in the process. Because of the apparent importance of benzoic acids in the metabolism of these bacteria, it was of interest to study the effect of streptomycin on it.

Resistance to streptomycin was induced in *Myco. tuberculosis* No. 607 by successive passage in Long's medium containing increasingly higher concentrations of the drug. Suspensions of the resistant strain and the normal parent strain were prepared from 3-day cultures on Long's medium by the method previously described (*1*). The bacteria were resuspended in M/20 phosphate buffer pH 6.7 so that 1.0 cc. of buffer contained 0.1 cc. of the packed centrifuged organisms, and 0.5 cc. of this suspension was used in each Warburg vessel, which contained a final volume of 2.0 cc.

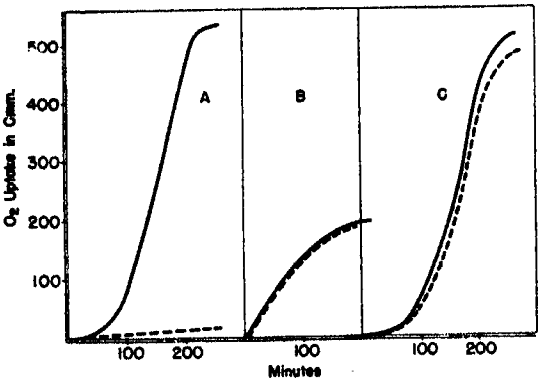

FIG. 1. A—Effect of 10 γ streptomycin on the oxidation of 1.0 mg. sodium benzoate by the normal 607 strain; B—Effect of 100 γ streptomycin on the oxidation of 2.0 mg. sodium pyruvate by the normal 607 strain; C—Effect of 100 γ streptomycin on the oxidation of 1.0 mg. sodium benzoate by the streptomycin-resistant 607 strain. The control uptakes have been subtracted. The dotted lines represent the addition of streptomycin.

Ten γ of streptomycin (Merck) completely inhibits the oxidation of 1.0 mg. of benzoic acid by the normal strain, whereas 100 γ is without effect on the oxidation by the resistant strain. The oxidation of pyruvic acid by the normal strain as well as its oxygen uptake without added substrate is not affected by 100 γ of streptomycin. This indicates that the inhibition of the benzoic acid oxidation by streptomycin may be fairly specific. The results are shown in Fig. 1. However, the increased oxygen uptake of the virulent H37 strain in the presence of benzoic acid is not affected by 300 γ of streptomycin. Other mechanisms must, therefore, be inhibited in this pathogenic strain.

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Suppression of Axillary Growth in Decapitated Tobacco Plants by Chemicals

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In the commercial production of tobacco the plant is topped or decapitated at the flowering stage and later "suckered," *i.e.* at intervals all subsequent axillary growth is removed. An inexpensive substitute for the operation of suckering without detriment to quality or yield would be of practical importance to growers.

It was with this final objective in mind that greenhouse trials were begun on suppression of axillary growth of topped plants. The chemical compounds employed included certain synthetic growth-regulating substances, some of which have been reported to possess the ability of retarding axillary growth. Powdered compounds were applied to the stem wound with a spatula after topping, and liquid compounds with a dropper. Decapitated plants retained 7 leaves at the time of treatment. The plants were harvested 35 days after treatment

TABLE 1

Treatment	Green moist weight				
	Leaf		Stem	Suckers	Total (grams)
	(grams)	(%)	(grams)		
Control 1, suckered	145.6	100.0	55.8	46.2	247.6
Control 1, unsuckered	114.7	78.6	52.7	132.3	299.7
Control 2, suckered	146.3	100.0	45.3	63.9	255.5
Control 2, unsuckered	140.1	96.0	53.7	145.9	339.7
γ-(Indole-3)-n-butyric acid	162.4	111.2	56.9	111.8	326.1
4-Chlorophenoxyacetic acid*	168.0	115.1	55.3	180.3	403.6
α-2-Chlorophenoxypropionic acid*	174.7	119.7	59.5	156.6	390.8
α-Naphthylacetic acid methyl ester*	165.8	113.6	68.2	0	234.0
2,4-Dichlorophenoxyacetic acid methyl ester*	175.2	120.0	78.0	72.0	325.2

*Courtesy of the Dow Chemical Company.

A few of the responses are given in Table 1. The figures, which are average values for three plants in grams of fresh weight, clearly indicate the possibility of controlling the relative development of the various parts of the tobacco plant.

The responses fall into several categories. In one, chemical suppression of axillary growth is accomplished in a degree equal to manual suckering, with as great or greater increase in yield of leaf. In another category, the yields of leaf, stem, and suckers are all increased considerably above those of the controls—apparently a stimulation response. Fuller details of the work will appear elsewhere.

These data indicate the possibility that it may be economically feasible to employ chemical suppression of suckers in the production of tobacco. However, experimental field work with these compounds under the actual conditions employed in the production of the different types of tobacco must be undertaken before their use can be recommended for this purpose. Such work is now under way with Maryland tobacco and with Rustica tobacco grown for nicotine.

Crystalline Kitol[1]

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Kitol has the interesting property of decomposing at elevated temperatures into vitamin A (*1*). This, and the possibility that it acts physiologically in inverse fashion to detoxify excessively high stores of vitamin A, has stimulated research to determine its structure. As a preliminary step we have prepared kitol in crystalline form and also its di-p-phenylazobenzoate ester.

The concentration procedure was different at certain stages from that previously described (*1*) and appeared to give a concentrate of slightly higher potency. Whale-liver oil (0.8 per cent kitol, 21,000 units of vitamin A/gram) was saponified, and the unsaponifiable matter was freed of sterols and other solids as far as possible by low-temperature crystallization from acetone. The resulting oil was mixed with constant-yield oil and residue oil (*2*) and distilled in a molecular still. A fraction rich in kitol was collected at 190–260°. This was stripped at 160°, after the addition of constant-yield oil and residue oil, to give a distilland rich in kitol and largely free of vitamin A. The unsaponifiable matter from the distilland was esterified with succinic anhydride; the acid succinate was neutralized in 83 per cent ethanol; and nonhydroxylic materials were separated by extraction with petroleum ether. By saponification a kitol concentrate [$E^{1\%}_{1\,\mathrm{cm.}}$ (290 mμ) = 586] was obtained which was sufficiently pure so that a crystalline di-p-phenylazobenzoate ester could be prepared. We were unsuccessful in preparing a crystalline 3,5-dinitrobenzoate, as described by Embree and Shantz, probably because of the nature of the impurities present.

Crystallization of the unsaponifiable matter from the phenylazobenzoate from methyl alcohol gave kitol in the form of colorless, elongated prisms. The yield was approximately 10 per cent, based on the amount present in the original whale-liver oil. Direct crystallization of the kitol concentrate, even after its extinction coefficient had been raised to 650 by chromatography, gave only a poor yield of crystals. This behavior may indicate the presence of geometric isomers.

Kitol melted at 88–90° (capillary tube method—CT; 95–97° in the Fisher-Johns apparatus—FJ), and $E^{1\%}_{1\,\mathrm{cm.}}$ (290 mμ) = 707. The analysis agreed with the formula $C_{40}H_{58}(OH)_2$, twice that of vitamin A. The crystals exhibited considerable stability toward atmospheric oxidation, for their ultraviolet absorption curve was unchanged after 53 hours exposure at room temperature in the dark. Kitol is more stable in air than vitamin A. In diffused daylight, however, only 44 per cent of the initial extinction coefficient was recovered in 46 hours. A solution of kitol in ethanol was relatively stable, losing only 7 per cent of its initial extinction coefficient after storage for 10 days in the dark at room temperature.

By distillation of kitol palmitate [$E^{1\%}_{1\,\mathrm{cm.}}$ (290 mμ) = 379] in a cyclic molecular still (from peanut oil residue; temperature, 240–270°; pressure, 3μ), values of 0.67 and 0.75 were found for the moles of vitamin A palmitate collected in the distillate per mole of kitol palmitate destroyed. Similar results were obtained by heating refined cottonseed-oil solutions of kitol and its acetate in sealed tubes, but less reliance could be placed on these data, since the vitamin A formed during decomposition was not removed from the heating zone and a correction of uncertain accuracy had to be made for this source of error. The data suggest that the breakdown of kitol by heat is not a clean-cut process in which one molecule of vitamin A and another fragment of unknown composition is formed. It appears more probable that a number of degradative changes occur, with vitamin A constituting one of the major products formed.

Kitol diphenylazobenzoate was found to exist in two forms. One melted at 125–126° (CT) and was obtained by chromatographing the crude ester on silicic acid, followed by crystallization from methyl acetate. A higher melting form [m.p., 149–150° (CT), 153–155° (FJ)] was isolated by chromatographing the crude ester on zinc carbonate, followed by crystallization from acetone. Refluxing the higher melting ester in acetone, chromatographing it on sodium aluminum silicate, or treating it with iodine in benzene, gave the lower-melting ester, but the conversion was not usually quantitative. The high- and low-melting forms gave colorless hydrazo compounds which appeared to be the same. They had nearly the same melting point (124–126° and 127–129°, respectively), and a mixed melting point determination showed no depression [127–129° (CT)]. It seems probable that the two azoates are geometric isomers of the carbon-carbon type, although the data on the hydrazo compound does not exclude nitrogen-nitrogen stereoisomerism.

A crystalline anthraquinone carboxylate ester [m.p., 195–197° (CT)] was prepared, but this proved to be less suitable for concentrating kitol. It also appeared to exist in a lower-melting form which was not obtained pure. The palmitate and dinitrophthalate esters were prepared but could not be crystallized.

Whale-liver oil is not unique in containing kitol. The substance was found also in dogfish-liver oil (0.06 per cent) and in shark-liver oil (0.8 per cent). The oils were conveniently assayed by chromatographing the unsaponifiable matter on sodium aluminum silicate. Kitol is adsorbed more strongly than vitamin A alcohol and a relatively sharp separation could be effected by inspection of the column with ultraviolet light. The purity of the kitol fraction was then estimated by its extinction coefficient at 290 mμ, using the value of 700 for the pure material. This procedure is recommended for the assay of kitol in fish-liver oils.

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[1] Communication No. 111.

IN THE LABORATORY

Production of Quantitative Infections With the Filariae of the Cotton Rat[1]

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The University of Texas Medical Branch, Galveston

Progress in the study of filariasis has long been retarded by the lack of an animal that can be infected in the laboratory. A step forward was made last year with the production of mass infections with *Litomosoides carinii*, the filaria of the cotton rat. Experiments recently completed in this laboratory have shown that it is now possible to produce quantitative infections with these worms, *i.e.* infections made with a known number of larvae and thus limited to a definite maximum size. This step opens the way for a new approach to the study of filariasis. In chemotherapeutic studies parallel series of treated and control animals infected with an approximately equal number of worms, all of which are of the same age, make possible more accurate determinations than with the wild-caught or mass-infected animals previously used. Moreover, the susceptibility of various species of animals, the possibility of a changing susceptibility with advancing age, and other phases of the immune response can now be studied by this method.

The details of the method are simple. Tropical rat mites, *Liponyssus bacoti* are raised on a white rat in a metal tank surrounded by an oil-filled moat. After three or four weeks an initial 50 mites will have produced a large colony, and an infected cotton rat is then substituted for the white rat. Ten days later this rat is removed, and in a few days the mites begin to migrate up the sides of the container. They are transferred by suction to vials, in which they are held until at least two weeks after their first opportunity for an infected blood meal. They are then examined in saline under a cover glass, and those containing larvae are placed in separate bottles. When a sufficient number is available, each mite is held in a drop of saline under a dissecting microscope by laying the tip of a bent needle across the thorax, and the tip of the abdomen is removed with a knife-edged needle. The viscera are expressed through this opening and the larvae teased free in the saline. These are transferred with a fine pipette to a drop of saline in the "hookworm larva counting slide" designed by the writer and listed by Arthur H. Thomas Company. In this slide the larvae can be easily counted as they accumulate from successive dissections. When sufficient are present, they are drawn from the slide into a #15 hypodermic needle, 3½ inches long. Care is taken not to draw them through the needle into the attached tuberculin syringe, but the syringe contains saline to rinse the larvae out of the needle when the injection is given under the skin of the back. A check against loss is made by again rinsing the needle into the slide.

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[1] Supported by a grant from the John and Mary R. Markle Foundation.

A Simple Method for Administering Nebulized Penicillin

David Glusker

Tigris 42, Mexico, D. F.

Increasing recognition of the advantages of the inhalation treatment with penicillin vapor has led to the development of many complicated devices. This communication is to suggest a simple apparatus for nebulizing and administering penicillin.

Advantage has been taken of the fact that the De Vilbiss nebulizer #40 has an aperture which exactly fits the BLB "oxygen mask" type A-8-A arctic, manufactured by the Ohio Chemical Manufacturing Company. The mask's rebreathing bag and its side arm are removed, and the glass nebulizer is inserted into the tube leading to the mask. The lower end of the nebulizer is connected to a source of compressed air or oxygen. A T-tube is inserted in the compressed air line so that the patient can control the pressure in the system. This is done by closing the T-tube with the finger, on inspiration, and removing it during expiration. Using a flow of 6 or 7 l. of oxygen/minute, or its equivalent in compressed air, results in nebulization of watery penicillin solutions which are then inhaled via the mask through the nose or mouth with complete comfort to the patient. The simplicity and availability of this apparatus make the administration of penicillin vapor convenient and foolproof.

An Interphase Analyzer of the Electroencephalogram[1]

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Interpretation of the electroencephalogram (EEG) is made at present almost entirely by visual estimate of wave forms, frequencies, phase, and amplitude relationships which are obtained from different areas of the cerebral cortex. Much of the interpretation of these records must always be done in this manner, for as an X-ray diagnosis, for example, there is no substitute for the skilled and experienced interpreter. But it is obvious that any additional objective measure of significant factors in these records would be of value not only in interpreting individual records but in comparing standards from the different laboratories now being established in many countries.

With this in mind, there have been a number of attempts to develop automatic or semiautomatic analyzers of these tracings. Frequency analyses, both manual (*1–4*) and automatic, are at present available, but these can be used only as research tools because of the complexity of instrumentation and assemblage of data. The present interphase analyzer, in contrast, requires little additional time or training and affords a measure of a single variable which is practically significant.

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[1] Aided by a grant from the New York Foundation.

The apparatus has been designed in such a manner that it can be connected between the pre- and power amplifiers of a 6-channel Grass electroencephalograph without alteration of standard equipment. Switches are provided to connect the analyzer with the EEG, or to disconnect it, at will. When disconnected, the usual 6-channel EEG record is obtained. When connected, 4 of the 6 channels continue to record the usual EEG while the remaining channels produce the phase analysis.

In the analyzer, the push-pull alternating potentials obtained from the preamplifiers are converted to single-ended operation (Fig. 1). This is accomplished by inverting half of the varying push-pull voltage of each of the preamplifiers of the first 4 channels. Both uninverted and inverted halves of the signal of each channel are then connected to ½-megohm resistors, and the single-ended output is taken from the junction of these. The single-ended output of channels 1 and 2 is fed to the grids of tubes V5 and V6, respectively; that of channels 3 and 4, to tubes V7 and V8, respectively. It will be noted that tubes V5 and V6 as well as V7 and V8 are operating in push-pull again. The output of the push-pull circuit V5 and V6 is then the analyzer voltage which is recorded as the instantaneous voltage differences between the activity of channel 1 and that of channel 2 on channel 5. Similarly, the output of the circuit V7 and V8 is the analyzed record of the simultaneous potential differences between the activity of channel 3 and that of channel 4, and appears on the record of channel 6.

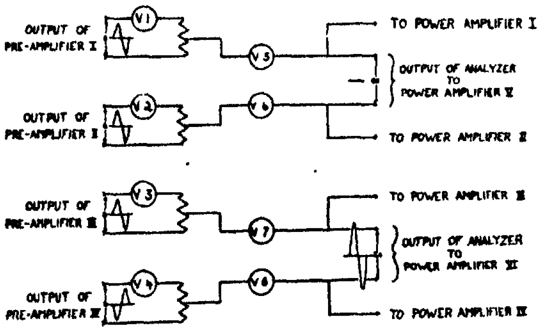
OUTPUT OF PRE-AMPLIFIER I
V1
OUTPUT OF PRE-AMPLIFIER II
V2
OUTPUT OF PRE-AMPLIFIER III
V3
OUTPUT OF PRE-AMPLIFIER IV
V4
V5
V6
V7
V8
TO POWER AMPLIFIER I
OUTPUT OF ANALYZER TO POWER AMPLIFIER V
TO POWER AMPLIFIER II
TO POWER AMPLIFIER III
OUTPUT OF ANALYZER TO POWER AMPLIFIER VI
TO POWER AMPLIFIER IV

Fig. 1. Diagram of circuits of interphase analyzer.

The operation of the instrument is best shown by records of the two possible extremes. Such records are always made as part of the calibration procedure during analysis of all EEG's. These limiting conditions are demonstrated in Fig. 1. Channels 1 through 4 are here recording from a single cortical area. Channel 5 shows the resultant analysis of the in-phase activity between channels 1 and 2. Since all activity is simultaneously in-phase, the output is zero, or a straight line on the record. Channel 6 depicts the analysis of the activity of channels 3 and 4 shown in complete phase opposition. The output here is double the amplitude of the original activity. This is true only if activity of both areas is approximately of the same amplitude. If a marked difference in amplitude exists, it must be taken into account by considering the base line to be the difference in amplitude of the two areas under analysis rather than zero. In the analyzer, frequency and phase differences are detected only by means of phase discrimination, the amount of frequency or phase discrepancy being expressed as phase shift. Hence, focal differences either in phase or frequency become significant.

Practically, it is well known that phase relationships between cortical areas are important. However, using the ordinary visual interpretation, their detection is limited to low frequencies within the range of alpha activity or less, since above that level the resolving power of the eye, the speed of recording, and the accuracy of pen alignment is too limited for detection of phase reversals. In these higher frequency ranges, the analyzer can show phase shifts or reversals which are significant. Furthermore, in many instances in which the EEG suggests a focus which is indefinite and in which phase reversals may be present only temporarily, clear delineation by use of the analyzer is often possible.

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Effective Copying of Kymographic Records

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The copying of kymographic or other smoked-paper records has many intrinsic difficulties well known to workers therewith. Direct copying can be done, using the record as the negative, and with such papers as Insurance Bromide grade RR (Eastman) fairly good results are obtainable. However, these as a general rule are not satisfactory for publication purposes.

Introduction during the war of new types of waterproof papers has entirely changed this situation, and copies of all records may be made with the greatest possible ease and success. The writer has experimented with several types of material including Resisto (Eastman) and some ex-Army material, but by far the best so far encountered is Grade 4 QUIK.[1] This material behaves like a medium chloride paper and is exceedingly tolerant of exposure variation, which is around 30 seconds for an ordinary tracing using 5 daylight bulbs dimmed to about half strength. Development is with ordinary hydroquinone 1;;1 developer and takes about 1-2 minutes. Fixing with fresh material may be complete within 3 minutes, and washing in free flowing water in 10 minutes. As the base is quite waterproof, drying is very fast, and not much curling occurs.

In order to facilitate printing and eliminate a great many unavoidable variations in smoking and varnishing, it is well to brush the back of the record, over the parts required for copying, with a mixture of light petroleum. This can best be done visually over the safelight in the printing box. Providing there is no actual excess of oil, no difficulties are occasioned thereby, and the paper can be placed immediately over the record and printed. One assistant and I completed over 80 such prints in 3½–4 hours. The records had been previously sorted, but the oiling was done at the time of printing. The oil, being volatile, slowly disappears and in no way harms the records.

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[1] Obtainable from Grant Photo Products, 401 4th Avenue, New York.

Fig. 1 shows an ordinary blood pressure and salivary secretion record obtained in this manner. Comparing this latter with the bottom time tracing, one may see the irregularities of a poorly working signal faithfully reproduced. This is not a picked tracing and is varnished with a particularly poor wartime material which would render ordinary photographic reproduction difficult.

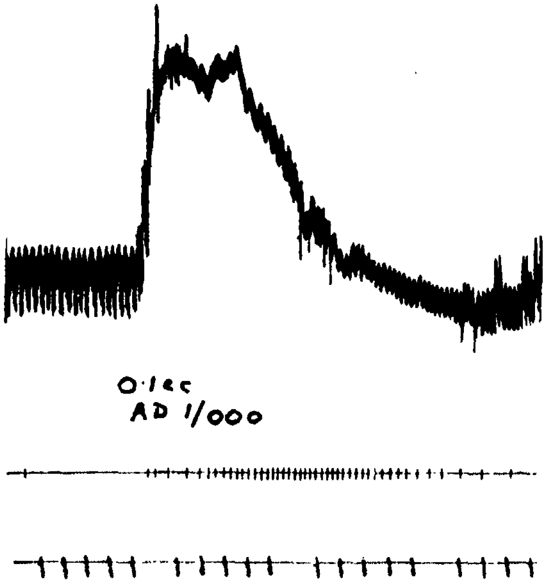

FIG. 1

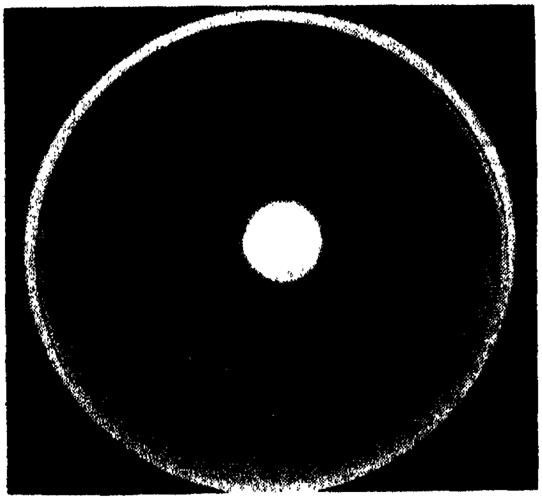

FIG. 2

The same paper serves well to make direct prints of culture plates for permanent record of antiseptic tests. An example of this is shown in Fig. 2, which depicts a 48-hour *Staphylococcus aureus* culture. For this purpose the lid must be removed. Under an ordinary 100-watt lamp at a distance of 2 feet a 2-second exposure is about right. Such records do not have the clarity of photographic reproduction because of irregularities in the culture dishes, but they are quite satisfactory for ring measurements and permanent records of such labile results.

An Adaptable Three-dimensional Graph Model

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Three-dimensional graphs offer a convenient visual means of evaluating the effects of two variable factors upon a third factor—for example, the effect of different temperature and moisture levels on the rate of inactivation of 2,4-D in soil. With the aid of such a graph maximum and minimum combined effects, contours, and trends are readily apparent.

Construction of this type of graph is generally time consuming. However, when once constructed, the graph described (Fig. 1) can be easily readjusted to present data obtained from various problems involving three different factors; or, where more than three factors are concerned, it can be made to show relations of combinations of these.

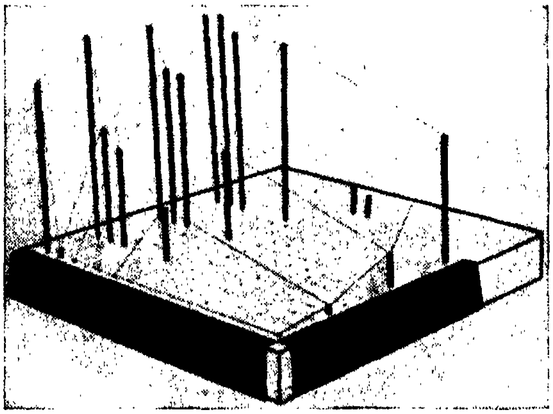

FIG. 1

This apparatus lends itself readily to photographic reproduction so that the data can be permanently recorded.

A board, 17 x 17 x ⅜ inches was marked off in square inches. Holes ¼ inch in diameter were drilled at the line intersections. The base was then painted with Kodak brushing lacquer No. 4. The upright pegs were made from ¼-inch doweling cut in lengths of ½, 1½, 2½,. . . 10½ inches as required; and, in this case, they were graduated in inches by pasting strips of black gummed paper around them. The upper ends of the series of pegs were connected by white cotton thread as shown in the figure. Clips to hold the thread were attached to the pegs with the aid of a gun-type stapler.

Data can be presented on this model in semilog form. A base graduated in logarithms would, of course, be necessary for log-log presentation.

Differences required for significance at the 5 and 1 per cent levels can be shown by pegs at one side of the graph.

Book Reviews

Introduction to atomic physics. (Rev. ed.) Henry Semat. New York: Rinehart, 1946. Pp. xi + 412. (Illustrated.) $4.50.

The increased need for training and understanding in atomic and nuclear physics brought about by the spectacular advances in "atomic energy" makes most timely this revised and enlarged edition of *Introduction to atomic physics*. The title refers to "atomic" not solely in the classical sense but in the modern sense in which the nucleus plays a major role.

The book is obviously written by a careful teacher with both the instructor's and the student's viewpoints in mind. The typography and illustrations are attractive, and there is at least one figure for every two pages of text. As a concise, one-semester, college-level introduction to the world of atomic physics, the book is admirable. It quickly leads the student into the realm of the infinitesimally small by an exposition that is attractive, yet surprisingly thorough. As a survey, the book is comprehensive and lends itself to self-study for the scientist in other fields. In each chapter there are problems which illustrate well the magnitudes of various factors involved and references to excellent texts which contain more subject detail. There is a nice balance between development of theory and illustration by experiment. Calculus is used in the theory only occasionally and then at an elementary level. When a mathematical proof is long, it is removed to the appendices.

The text does not unfold in the customary historical manner, which too often confuses the student, but breaks naturally into three general parts by category. "The Extranuclear Structure of the Atom" and "The Nucleus" are preceded by a section on "Foundations of Atomic Physics," which occupies roughly half the book. This section is logically divided into an essential short résumé of classical electricity and magnetism, which is immediately put to practical use to interpret both the wave and particle manifestations of atomic structure. These follow under the three headings: "Elementary Charged Particles," "Electromagnetic Radiation," and "Waves and Particles." Alpha particles, cathode rays, electrons, ions, and even the mass spectrograph and stable isotopes are discussed under the first heading; photoelectric effect, Zeeman effect, and X-rays are embraced under the second; and the duality concept of waves and particles, electron diffraction, Heisenberg's uncertainty principle, and Schrödinger's equation are masterfully treated in the third.

The hydrogen atom is discussed from the viewpoints of both quantum and wave mechanics, in the portion devoted to the extranuclear structure, and is followed by sections on atomic spectra and electron distribution.

Part III, "The Nucleus," consists of chapters on "Natural Radioactivity," "Disintegration of Nuclei," and "Nuclear Energy." This part has been brought up to date to include concise but adequate treatment of nuclear reactions produced by various bombarding particles, radioisotope production and properties, nuclear transitions, fission, photofission, transuranic elements, chain reactions, and even an atomic bomb! Future editions will no doubt contain an expanded Part III.

There is the unorthodox but effective separation of Rabi's magnetic resonance method from the Stern-Gerlach experiment. The theory of the betatron is not juxtaposed with that of the cyclotron and electrostatic generator but is included as a new and different type of X-ray source in the discussion on X-rays. The latter was done not without recognition of the development of the betatron as a means of nuclear and cosmic-ray study, but probably to introduce early in the book an application of electromagnetic principles in a useful modern device.

This reviewer found both the arrangement and the content stimulating. The book is recommended without reservation for starting the college-level student on his way to a technical understanding of the atomic age.

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Oak Ridge, Tennessee

Explosion and combustion processes in gases. Wilhelm Jost. (Trans. by Huber O. Croft.) New York-London: McGraw-Hill, 1946. Pp. xv + 621. (Illustrated.) $7.50.

For those unable to read German, the translation of this important work should serve a useful purpose. Those at home with German, or moderately so, will derive a distinct advantage from the German edition in an appreciation of the spirit behind the original documentation—something that the reviewer considers lacking in the translation. While the translator performed a faithful and creditable work, the worker in the field of flame and combustion must be disturbed by the awkwardness of expressions, which make reading and sometimes comprehension difficult. For example, the following sentence occurs on page 22: "According to whether the surface in question introduces or breaks off reaction chains especially vigorously, the surface will begin to be effective at particularly low or only at very high temperatures." If one substitutes the accustomed word usage of the field of chain reactions—"initiates" for "introduces," "terminates" for "breaks off," and "efficiently" for "especially vigorously"—the sentence then becomes meaningful. The usual term, "Faraday dark space," is translated as "Faraday dark section."

We again find incorrect translation in the definition of the auto-ignition process (p. 1). The translator has written: "Auto-ignition processes include all those phenomena based upon the fact that, in an explosive mixture heated to an infinitesimal degree, the rate of reaction as the result of the infinitesimal change increases beyond all bounds." Jost says (correctly): "Auto-ignition processes are all phenomena based on the principle that in an explosive mixture heated to onset of barely noticeable reaction, the reaction velocity ultimately increases beyond all limits as a consequence of this primary small chemical change."

The reviewer does not know the extent of trivial errors in the book, but a brief random search revealed the following: the date "1935" instead of "1939" (p. vii); "methane yields" instead of "methanol yields" and "O_2" instead of "O_3" (p. 415); and "$C_{14}H_{46}$" instead of "$C_{34}H_{66}$" and "substance" instead of "substances" (Table 12, p. 581).

The author index appears incomplete, but mathematical equations seem to be reproduced faithfully and well, and the arrangement and typography are excellent. A conversion table from c.g.s. to f.p.s. has been added by the translator.

Apparently, in his zeal to couple Jost's book to the much-publicized and fetching term, "jet propulsion," the publisher has misstated on the cover page that the book is "A translation of the classic German work on jet propulsion." This, Jost's book is not—the term "jet propulsion" does not even appear.

Despite the above, this translation should fill a needed gap for those who, for one reason or another, have been deprived of reading Jost's book in the German.

BERNARD LEWIS

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Basic mathematics for technical courses. Clarence E. Tuites. New York: Prentice-Hall, 1946. Pp. xiv + 309. $5.00.

This book covers the material usually treated in trigonometry and precollege algebra courses. The approach is standard but is in some respects better suited to the needs of the technical man than most existing texts. The author is to be commended on the representative choice of problems from all fields of engineering, the inclusion of Kirchhoff's laws in his discussion of linear equations, as well as the use of j for $\sqrt{-1}$ instead of i, so easily confused with electric current. On the other hand, the viewpoint is not rigorous. The author tends to talk around his subject instead of saying exactly what he means. By the addition of four or five pages the presentation could be made mathematically correct without detracting from the clarity of the subject.

Needless to say, the average elementary textbook on mathematics is in some respects a hundred years behind the times, each author copying over the errors of the preceding. Thus, Tuites introduces the "axioms" of equality as "self-evident truths," a notion long outmoded but still persisting in the textbook literature. The treatment of numbers is incomplete, although more of the logic is included than in many comparable works.

It is assumed here that the reader is familiar with the operations of multiplication, division, addition, and subtraction. Many excellent short cuts for performing these operations in special cases are given, such as adjoining two zeros and dividing by 4 instead of multiplying by 25. Although these short cuts are in common use, they are seldom listed for the student. Significant figures, the checking of computations, and other arithmetical topics are brilliantly explained.

The book begins with a discussion of the slide rule, so that if the reader does not reach the chapter on logarithms, he will at least know about this application. From arithmetic the reader is led to polynomials, radicals, and imaginary numbers. The latter are explained geometrically through rotations, a popular viewpoint. With this background the reader is introduced to the solution of algebraic equations. Since this subject is not carried very far, the extremely useful process of synthetic division is not attained. The book closes with some chapters on plane trigonometry which leave little to be desired. Five-place tables of logarithms and trigonometric functions are given at the end.

Written by an instructor at the Rochester Institute of Technology, this book was intended for industrial and extension schools, as well as for technical institutes and junior colleges. The book is particularly well suited to the man who has forgotten his algebra and trigonometry or who has never studied these subjects and wishes a clear, elementary, and practical presentation. Except for questions of rigor, which would normally not bother the average reader, this work is admirably adapted to the purpose for which it was written.

RUFUS OLDENBURGER

Illinois Institute of Technology, Chicago

✓***Physical chemistry.*** H. Hunt. New York: Thomas Y. Crowell, 1947. Pp. x + 610. (Illustrated.) $4.75.

In the preface to this text, the author states, in part: "Since one cannot be sure what the future chemist will need to know, all the fundamental topics of physical chemistry are presented with proper regard to their relative importance." It would be difficult indeed to find a topic of interest to physical chemistry which is not at least mentioned. Many topics are given a more thorough and precise treatment than is customary in the usual text for beginners in physical chemistry. Among these topics are: kinetic properties of gases, crystal structure of solids, atomic spectra and structure, chemical kinetics, and theory of electrolytic solutions. The large number of tables of data, the many illustrations, and numerous problems add much to the value of the book.

Specific objections can be made to details of treatment of some of these topics, but in general a fairly successful compromise is made between a completely rigorous and a descriptive treatment. The compromise would be much more successful if a more orderly presentation had been made. It was the announced plan of the author to make each chapter as nearly as possible an independent unit. As a result of this plan, concepts are frequently introduced which are not explained until several paragraphs or even chapters later. This requires considerable search on the part of the student and instructor to find the necessary background for a given deduction. This search might in itself be a good thing in the case of a large reference work, but in this text it leads to excessive repetition of concepts and equations. Preferably, the material of a text should be presented in a unified, logical order. The extent to which a given topic is to be pursued could be left to the instructor, as it must be in any case.

The treatment of elementary principles of thermodynamics is confusing and is the part of the text most open to criticism. Many formulas which are true only for the ideal gas are given without this qualification. The inexperienced student will no doubt believe that the relations have general validity. An example of this can be seen on page 90, especially the latter part of equation (3–2), and several unnumbered relations near by. Several equations in this section are in error or are misprinted. The statement of the second law as $\Delta F = \Delta H - T\Delta S$ (p. 98) may not be helpful to the student, since the entropy, aside from a complicated "definition" on page 93, is not discussed and explained until page 112. The function F is defined and extensively used, but the essential reason for its introduction is nowhere clearly stated, or could not be found by this reviewer. An orderly treatment of thermodynamic principles might well have formed the first chapter, since an extensive discussion of fugacity is given in the present first chapter.

This text may prove stimulating to small classes of special students under the direction of experienced instructors. In the case of large, heterogeneous classes, as are usually found today it will be of considerably less value.

A. B. F. DUNCAN

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The electronic theory of acids and bases. W. F. Luder and Saverio Zuffanti. New York: John Wiley; London: Chapman & Hall, 1946. Pp. ix + 165. (Illustrated.) $3.00.

This little book, dedicated to G. N. Lewis and read in manuscript form by him before his death, has as its principal thesis the propagation of Lewis' electronic theory of acids and bases. In reading the book one has the feeling that here are two ardent disciples of Lewis who are attempting enthusiastically to spread the true gospel. The 13 chapters are entitled: "Historical Background," "Atomic Orbitals and Valence," "The Electronic Theory of Acids and Bases," "Electrophilic and Electrodotic Reagents," "Acidic and Basic Radicals," "Neutralization," "Titration With Indicators," "Displacement," "Catalysis," "Acid Catalysis," "Base Catalysis," "Alkoxides as Catalysts," and "Conclusion."

By way of illustrating the points they wish to make, the authors have collected together and organized in a readable fashion a large amount of interesting and instructive data. Every chemist could benefit by reading this book because of its many suggestive and provocative postulates and theories. However, unless one reads critically, he may conclude that the electronic theory of acids and bases constitutes the whole and complete story of the phenomena considered. To test the accuracy of the theories and data presented, the reviewer made a detailed study of the authors' description of one base-catalyzed reaction, the aldol condensation of acetaldehyde (p. 138) (this being picked more or less at random from the large number in the book). Here we are told that the catalysts used are bases such as acetates, carbonates, pyridine, and amines, and the reference given is to a paper by the noted Oxford physical chemist, R. P. Bell. In that paper, however, Bell states specifically that the aldol condensation of acetaldehyde is catalyzed only by the hydroxide ion, and that acetate ions cannot catalyze the reaction by themselves but only to the extent that hydroxide ions are produced by hydrolysis. Luder and Zuffanti give no hint that any other mechanism of aldol condensation is possible, yet at least one other slightly different mechanism which fits all the facts can be imagined. Nor do they indicate that at low hydroxide-ion concentration the simple mechanism is no longer valid.

One is struck by the practically complete lack of quantitative data, graphs, and equations. No rate equations, for example, are given, despite the fact that nearly one-third of the book is devoted to the subject of catalysis. Nevertheless, read critically and with mental reservations, the book has much to contribute to the chemical thought of the day.

MALCOLM DOLE

Department of Chemistry, Northwestern University

Analytic geometry and calculus. John F. Randolph and Mark Kac. New York: Macmillan, 1946. Pp. ix + 642. (Illustrated.) $4.75.

The authors of this text write in a vigorous, clear, and simple manner, dropping many unnecessary terms, yet pointing out many pertinent facts which are often neglected.

Although the material in the calculus is essentially traditional, the authors break new trails in handling many details. Maclaurin is not mentioned in connection with Taylor's theorem. The inverse trigonometric functions are defined as one-valued (with no reference to principal values). The sections on analytic geometry are reduced to a minimum, but are carefully and effectively handled. The device of leaving some difficult details to more extensive works and of putting much more in small print leaves a consecutive course in large print devoted chiefly to technique and to clarification of the essentials. A more than usual emphasis is placed upon discontinuities and limited domains. Many of the proofs are particularly gratifying in their rigor and simplicity. Duhamel and all his works are ignored. Gauss's rules for approximation are developed, but no section discusses significant figures or Newton's method. The figures are in most cases excellent.

The only serious criticism of items that have been included concerns the authors' random use of "f" (in isolation). This sometimes refers to the whole correspondence, sometimes to the value assumed by the dependent variable. The omissions are not easily condoned. In clearing out the rubbish, the authors have retained subnormals and subtangents, yet nothing is said concerning hyperbolic functions, simple harmonic motion, the catenary, convergence of series, angular velocity and acceleration, orthogonal curves, vectors, or such engineering notions as deflection of a beam or modulus of a spring.

Despite the many unexpectedly good features of this text, the course remains pretty thin in applied content. For most physicists and engineers, one might demand a more nourishing fare.

ALBERT A. BENNETT

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Organic reactions. (Vol. III.) Roger Adams. (Ed.-in-Chief.) New York: John Wiley; London: Chapman & Hall, 1946. Pp. viii + 460. (Illustrated.) $5.00.

This volume carries out the plan of the first two volumes of the series, also edited by Roger Adams with the collaboration of Werner E. Bachmann, Louis F. Fieser, John R. Johnson, and H. R. Snyder. It comprises critical discussion of 9 classes of organic reactions. As stated in the preface to the series, "The subjects are presented from the preparative viewpoint, and particular attention is given to limitations, interfering influences, effects of structure, and the selection of experimental techniques. Each chapter includes several detailed procedures illustrating the significant modifications of the method. . . . When all known examples of the reaction are not mentioned in the text, tables are given to list compounds which have been prepared by or subjected to the reaction."

The chapters of the volume are as follows: 1, "The Alkylation of Aromatic Compounds by the Friedel-Crafts Method," by Charles C. Price; 2, "The Willgerodt Reaction," Marvin

Carmack and M. A. Spielman; 3, "Preparation of Ketenes and Ketene Dimers," W. E. Hanford and John C. Sauer; 4, "Direct Sulfonation of Aromatic Hydrocarbons and Their Halogen Derivatives," C. M. Suter and Arthur W. Weston; 5, "Azlactones," H. E. Carter; 6, "Substitution and Addition Reactions of Thiocyanogen," John L. Wood; 7, "The Hofmann Reaction," Everett S. Wallis and John F. Lane; 8, "The Schmidt Reaction," Hans Wolff; and 9, "The Curtius Reaction," Peter A. S. Smith.

Of particular interest to the reviewer was the chapter on the Willgerodt reaction and the Kindler variation of it. This is the reaction by which a ketone is converted to an amide by the reaction of ammonium polysulfide. It is an unusual reaction in the sense that a ketone such as ethyl phenylketone is converted into β-phenylpropionamide by this procedure, and there is considerable speculation as to the mechanism.

The chapter on "Azlactones" contains a large amount of interesting material which is not commonly discussed.

The material given in the chapter on the Schmidt reaction (reaction of hydrazoic acid and carbonyl compounds in the presence of strong mineral acid) will be found useful to those interested in the synthesis of amines, amides, and their derivatives.

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Smith's college chemistry. (6th ed.) William F. Ehret. New York-London: D. Appleton-Century, 1946. Pp. xii + 677. (Illustrated.) $4.75.

This revision is written under new authorship and from a fresh viewpoint, which sets it apart from the other editions; the author deserves more credit than the title would imply.

The text content is quite comprehensive and up to date. The sequence of topics is classical and seems to be well integrated, even though several times the author appears to be grasping for a connecting link. The method of presentation and quality of material indicates, however, that this edition is intended for the better student who has already had a course in chemistry in high school.

A feature well worth mentioning is the use of boldface print for new terms, for definitions, and for general emphasis.

Such topics as atomic structure, equilibria, and ionization seem to be adequately treated. A chapter on "Energy and Chemical Change" and another on "Electromotive Chemistry and Voltaic Cells" are well placed.

In general, however, the figures and pictures are very poorly executed, as demonstrated in Figs. 7, 11, 13, and 14 (which would not be recognized as a balance arm). This fact and the lack of sufficient pictorial material to break up the large pages give the book an unfortunately dull and drab effect. This is particularly true of the early chapters, which are already quite dull because of the subject matter contained in them.

Among items that can be listed as unfortunate are the use of the phrases "throw light on" and "sealed up the mouth" (p. 7); the statement, "Two substances can come together in two different ways" (p. 8); the definition of chemical property as a chemical reaction (p. 8); the verb in the sentence "The negative radicals stem from chlorine atoms . . ." (p. 71); and the use of double dots to show ratios (p. 111). Also, the periodic table (p. 178) contains elements 93, 94, 95, and 96 in positions not justified by their chemical properties.

A. B. Garrett

Department of Chemistry, The Ohio State University

Practical physiological chemistry. (12th ed.) P. B. Hawk, B. L. Oser, and W. H. Summerson. Philadelphia: Blakiston, 1947. Pp. xiv + 1323. (Illustrated.) $10.00.

The 12th edition of this work appears on the 40th anniversary of the publication of the first under the signature of the senior author. The several revisions form a running commentary on the tremendous growth of physiological chemistry in this first half of the century. Inasmuch as 10 years have elapsed since the appearance of the 11th edition, revision for the 12th is considerably greater than for most of the earlier issues. The coverage of subjects is broader than ever, including tissues, foods, enzyme action, digestion, absorption, putrefaction, excretion, respiration, metabolism, hormones, vitamins, and antibiotics. It is up to date enough to include brief mention of the synthesis of penicillin G and production of isotopes by controlled nuclear fission. The table of atomic weights includes neptunium; however, virginium and alabamine likewise are there.

As in previous editions, laboratory procedures are given in sufficient detail to be followed easily. Presumably the authors are aware that their text is frequently used as a reference work as well as a teaching text. For these reasons the sharpening of certain minor points would be desirable. For example, the first experiments on dialysis include no recommendation for testing the membranes for leaks (p. 9); and perhaps it should be emphasized (p. 516) that, even with the improved Brown procedure, uric acid cannot be added to blood and satisfactorily recovered. In spite of these very minor criticisms, this revision will be welcomed by its friends and will undoubtedly win many new ones.

The text is handsomely bound, and the printing is unusually clean.

Benton B. Westfall

Boyds, Maryland

Advances in carbohydrate chemistry. (Vol. 2.) W. W. Pigman and M. L. Wolfrom. (Eds.) New York: Academic Press, 1946. Pp. xiv + 323. $6.60.

The second volume of this series is again a valuable contribution to the field of carbohydrate chemistry. In contrast to reviews published during the war years, it is, as the preface states, international in scope: four reviews are presented by English authors, one by a French author, one by Canadian reviewers, and, in addition, there are four contributions by Americans.

Melezitose and turanose are the subjects discussed by Hudson. Evidence is presented to prove the structure of both the disaccharide and the trisaccharide. A thorough discussion of the anhydro sugars, presented by Peat, includes a comprehensive table of the properties of the anhydro sugars and their derivatives which should prove very valuable. Analogues of ascorbic acid is the topic discussed by F. Smith. Various syntheses are given, and the correlation between physiological activity and structure is presented. Lespieau describes the synthesis of hexitols and pentitols, giving rather detailed procedures for the preparation of the alcohols and some of their derivatives. The interrelation of carbohydrate and fat metabolism is reviewed by Deuel and Morehouse, who not only present evidence for the conversion of carbohydrate to fat and the alleged reverse transformation but also include a rather complete discussion of ketolysis versus antiketogenesis. In the review of mucopolysaccharides and mucoproteins, by Stacy, an excellent classification of the various complexes is presented. Evans and Hibbert, in their review of bacterial polysaccharides, emphasize the complexity of the problems, although indicating that definite progress is being made in this difficult field. The chemistry of the pectic materials is reviewed by Hirst and Jones, while McDonald discusses polyfructosans and difructose anhydrides. Many properties of these sugars and their derivatives are listed. The final review, contributed by Haskins, concerns cellulose ethers of industrial interest.

The book is especially valuable because the authors are actively working in the fields concerned. Each reviewer gives an historical background in the subject discussed. Such information is, of course, available in the literature, but a concise summary is always to be desired. The volume is well edited and contains a wealth of material essential to anyone interested in the field of carbohydrate chemistry.

JOSEPH S. BUTTS

Department of Chemistry, Oregon State College

Advances in enzymology and related subjects of biochemistry. (Vol. VI.) F. F. Nord. (Ed.) New York: Interscience Publishers, 1946. Pp. x + 563. (Illustrated.) $6.50.

Like its predecessors, this volume contains critical documented summaries of the advances in the borderland between physical and biological chemistry, physiology and microbiology.

In "The Bacterial Amino Acid Decarboxylases," E. F. Gale discusses the conditions necessary for their formation, the cell-free preparation of them, their properties, and their resolution into apo- and coenzymes. Pyridoxal phosphate appears to act as coenzyme for the four known decarboxylases; in acid solution it may have a protective function. M. G. Sevag reviews "Enzyme Problems in Relation to Chemotherapy, 'Adaptation,' Mutations, Resistance, and Immunity." "Adaptive" enzymes do not exist; unfavorable metabolic environment merely reduces the activity of enzymes already present. The biochemical changes in increased resistance to unfavorable conditions appear genetically to be regressive processes; the development of new strains implies acquisition, by a recessive cell, of genetic factors from cells of a higher order. D. W. Wooley, writing on "Biological Antagonisms Between Structurally Related Compounds," states that these can in most cases be explained by the displacement hypothesis.

"Adenosine Triphosphate Properties of Myosin" is the contribution of V. A. Engelhardt. These are such that all of the ATP in muscle could be split by myosin in one second. Conditions responsible for the inaccessibility of ATP are considered, and a tentative scheme for the sequence of events is proposed. In "States of Altered Metabolism in Diseases of Muscle," by C. L. Hoagland, are included atrophy, hypertrophy, and diseases of voluntary muscle in man. "Acetyl Phosphate," discussed by F. Lipmann, plays a role in the metabolism of bacteria and of animal tissues; the chemical and energetic relations are surveyed. In "Microbial Assimilations" C. E. Clifton includes those of carbon, carbon dioxide, and nitrogen, as well as the influence of poisons and of genetic factors. W. G. Frankenburg writes on "Chemical Changes in the Harvested Tobacco Leaf." In the curing process these changes affect the static, nitrogen, and dynamic groups in the leaf and are the result of the action of the leaf enzymes. "The Actions of the Amylases," by R. H. Hopkins, and "The Amylases of Wheat and Their Significance in Milling and Baking Technology," by W. F. Geddes, survey the properties of the amylases, their occurrence and assay, and their significance in breadmaking. K. C. D. Hickman and P. L. Harris, in "Topocopherol Interrelationships," suggest a general shortage in the American diet, as well as many synergistic relations which warrant greater consideration, but it is difficult to disentangle fact from theory and vitamin from covitamin.

An author index (22 pp.) and a subject index (13 pp.) add to the usefulness of the book.

H. A. MATTILL

Department of Biochemistry, State University of Iowa

Vitamins and hormones: advances in research and applications. (Vol. IV.) Robert S. Harris and Kenneth V. Thimann. (Eds.) New York: Academic Press, 1946. Pp. xvii + 406. (Illustrated.) $6.80.

This volume will undoubtedly enjoy the same wide acceptance and use as have the preceding volumes. It is not a review in the usual sense, since only a limited number of subjects are treated. However, each subject is covered comprehensively, aiming to give both detail and a broad understanding of the subject. Cross indexing and extensive bibliographies increase its value as a reference book.

Many of the subjects treated are quite timely because of widespread interest in their practical applications. The section on "The Newer Hematopoietic Factors of the Vitamin B Complex" is especially timely because of the recent demonstration that pteroylglutamic acid (folic acid, *L. casei* factor, etc.) has antianemic activity in man. It is unfortunate that this review was written before many of the clinical results became available. However, the authors were able to append a few paragraphs summarizing these recent developments.

The section on "Thyroactive Iodinated Proteins" is also quite timely, since the use of these substances to increase yields of milk and eggs is receiving considerable attention in agricultural circles. Details as to methods of preparation, properties, and methods of assay are given.

To those who have been confused by the many apparently conflicting results the section on "Nutrition and Resistance to Infection" should be of help. The author has reviewed the available evidence in a critical fashion and has indicated certain basic considerations important to a general understanding of the problem.

The volume includes a unique article on "Manifestations of Nutritional Deficiency in Infants." The author has apparently had unusual opportunities to study this subject and has collected information which should be useful to both nutritionists and pediatricians.

Two chapters deal with vitamin-hormone interrelationships. "The Effect of B Vitamins on the Endocrinologic Aspects of Reproduction" deals with experimental aspects of this complex and relatively undeveloped subject. The second of these chapters, "Nutritional Therapy of Endocrine Disturbances," attempts to apply certain laboratory observations to man. While there seems to be little doubt that there is a definite relationship between nutritional status and hormonal balance, it is difficult to evaluate the clinical claims. Some workers have been unable to confirm the widespread usefulness of this technic, as indicated in the review.

The chapter on "The Thyroid and Diabetes" presents a review of the available experimental data and discusses the practical aspects of the interactions of these glands.

Another section deals with "The Protein Anabolic Effects of Steroid Hormones." It seems well established that these substances do exert an effect on nitrogen retention and protein synthesis. Whether these interesting observations will have practical usefulness, except in certain endocrine states, seems to merit further investigation.

The final chapter describes "Methods of Bioassay of Animal Hormones" and deals especially with the anterior pituitary and adrenal cortical substances. For those attempting such determinations this chapter should prove most useful.

In general, the presentations are well chosen and carefully written, and most are critically evaluated. The defects are minor and more than compensated by the wealth of information presented.

James M. Hundley

Division of Physiology,
National Institute of Health, Bethesda, Maryland

Medical biochemistry. (2nd ed.) Mark R. Everett. New York-London: Paul B. Hoeber, 1946. Pp. xii + 767. $7.00.

While the author's main objective in writing the first edition was to provide a readable text for medical students, the second edition "was undertaken to provide accurate modern information for students and others who regard the book as a convenient reference volume." This change in objective was effected without substantial change in the arrangement, scope, or nature of the contents.

The subject matter is arranged in an interesting, although somewhat unusual, manner. The first two chapters are devoted to acid-base relations, colloids, enzymes, and energy metabolism. Following the subject of digestion, the chemistry, metabolism, and pathology of the lipides, carbohydrates, proteins, inorganic substances, vitamins, and hormones are treated in order. The author has covered the material in these chapters in an adequate manner without making the volume encyclopedic. He has incorporated in the new edition most of the recent developments in biochemistry, such as the antibiotics, Rh factor, dicumarol, phosphorylation, etc., and has expanded such topics as anoxia, plasma proteins, vitamins, muscle diseases, hypertensive factors, and ketogenesis.

The usual historical approach characteristic of most writers in this field has intentionally been eliminated, and the author has "avoided unnecessary speculations and argumentative considerations." However, he has placed at the end of each chapter a well-arranged bibliography of selected modern reviews. Although the book contains many tables and some diagrams, it is lacking in illustrations and color plates. Generally, each topic is preceded by an interesting literary quotation. A comprehensive index and a separate index to the tables and diagrams are included.

Students and workers interested in the various aspects of biochemistry will find this book a helpful addition to their library.

Emil G. Schmidt

School of Medicine,
University of Maryland, Baltimore

Penicillin in syphilis. Joseph Earle Moore. Springfield, Ill.: Charles C. Thomas, 1947. Pp. x + 319. (Illustrated.) $5.00.

This supplement to *The modern treatment of syphilis* which has appeared in monographic form deals with the use of penicillin, either alone or combined with other therapeutic agents, in the treatment of the various manifestations of syphilis. To those who possess or will possess the parent volume this small book will prove a welcome and valuable addition. Except for an interesting discussion of reinfection and superinfection, there is no new knowledge in this monograph concerning other forms of treatment or the fundamental biology of syphilis.

The first eight chapters are devoted to a discussion of the pharmacology, toxicity, and mechanism of the action of penicillin and to other basic considerations. The majority of these chapters, while containing much that is important and fundamental, have little worth in the practical management of the patient. To the specialist, and to the experimentalist, they are of great and long-lasting value.

The remaining chapters deal with the use of penicillin in the management of syphilis in the human being, and one small chapter is devoted to treatment with streptomycin. The material is taken largely from the reports of the many civilian clinics and laboratories and installations of the Army, Navy, and Public Health Service cooperating in the organized nationwide study of penicillin in the treatment of syphilis.

As Moore admits, much of the material presented may be outdated by the time of publication, particularly as this material applies to the treatment of the patient who has syphilis. The basic considerations remain the same, but dosage schedules are being revised constantly. It seems unfortunate, then, that only three pages are devoted to the present-day treatment of early syphilis while many more pages are used to discuss obsolete dosage schedules which, while of experimental and historical interest, are of little value in the practical management of the patient.

The knowledge to date indicates that penicillin is of value in the treatment of certain of the late forms of syphilis. Beyond that, little may be said. For this reason, the chapters on latent and cardiovascular syphilis are justifiably short. Those chapters on penicillin in neurosyphilis, prenatal syphilis, and syphilis in pregnancy are incomplete but contain many worth-while practical aspects of treatment and observation. The true status of treatment of syphilis with penicillin and concrete deductions from its use cannot be made for several or more years, as Moore has recognized in the introduction.

The bibliography is complete up to October 1946. Many important articles since that date have appeared in the more prominent medical journals, and to these the readers of this volume should have easy access.

The typography and format of the volume are superior. The figures and tables admirably illustrate the statements of the author.

All in all, the purposes of this monograph seem to have been accomplished. Undoubtedly, it will be replaced in a few years by its combination with a new edition of *The treatment of syphilis* with greater and more lasting conclusions. For the future it will have historical interest and value. New chemotherapeutic agents undoubtedly will be developed, and reference to this volume will be of great aid in determining the approach necessary for their proper appraisal.

ROBERT R. KIERLAND

Mayo Clinic, Rochester, Minnesota

Biochemistry of cancer. Jesse P. Greenstein. New York: Academic Press, 1947. Pp. viii + 389. (Illustrated.) $7.80.

Research on cancer has been relatively slow in development and, as an experimental science, began only at the beginning of the present century. The long tradition of pure morphologic study had meantime fastened itself with throttling grip on the investigation of neoplastic disease, and cancer research itself in effect was, until recently, suffering from an intellectual cancer. It is one of the strange vagaries of science that chemistry, instead of being introduced early, has been the latest of the disciplines to enter cancer research.

There have been several previous treatises on the chemistry of cancer, but all have consisted of undigested collections of facts and errors, assembled magpie fashion, containing some good data but with so much trivial dross as to make them valueless. Also, as the author aptly states: "More chemists than one have blundered in oncology, not so often on the basis of poor oncology as of bad chemistry. For some odd reason, cancer research has been the graveyard of many a scientific reputation."

The present volume, then, is unique in that it assembles for the first time quantitative chemical data which are discussed in a critical manner. It is more than the biochemistry of cancer; it includes a great deal of information on the ancillary sciences-- the physiology, genetics, and even taxonomy of the neoplastic state.

After an orienting introduction the volume is divided roughly into three parts which deal, respectively, with chemical aspects of the induction, control, and properties of tumors. Since the author is one of the leading enzymologists, the catalytic factors naturally receive greatest emphasis, but this is felicitous in that the enzymes of cancers are, in the thoughts of many workers, agents of very high importance. Dr. Greenstein's forte has been the study of the spectrum of the protein catalysts in normal, neoplastic, and germane states. As a generalization, he has arrived at the conclusion that tumors tend to converge, enzymatically, to a common type of tissue and to resemble one another rather more than the tissues of origin.

This volume represents a vast amount of scholarship and will be indispensable reading for all workers in cancer research, whether savant or tyro. It is destined, no doubt, to become dog eared in scores of laboratories.

The style of the author is characterized by elegance and simplicity, and his writing is occasionally enlivened by nice touches of pointed humor and stimulating speculation. The only criticism of this work deals with the modesty of the author, which is so great that he has not included himself in the author index.

Dr. Greenstein is well qualified to write this volume, being head biochemist at the National Cancer Institute. His important contributions to the quantitative chemistry of proteins are well known. His studies and this book are in the best tradition of the U. S. Public Health Service, of which he is a distinguished member.

CHARLES HUGGINS

Department of Surgery, University of Chicago

Parenteral alimentation in surgery with special reference to proteins and amino acids. Robert Elman. New York-London: Paul B. Hoeber, 1947. Pp. xx + 284. (Illustrated.) $4.50.

Dr. Elman has brought forth a timely and distinguished book. Although written primarily for the surgeon, it should be read by all workers, clinical as well as laboratory, whose work touches the healing art, human or animal. The book deals with the administration, to patients unable to assimilate food by the gastroenteric route, of the basic units of the six substances which are concerned with the maintenance of corporal integrity, namely, water, minerals, vitamins, carbohydrates, fats, and proteins. For the surgeon, preoccupied with the exacting demands of his strenuous professional life, this volume is both a bringer of gifts from the basic disciplines of biochemistry, nutrition, and physiology and a manual at once comprehensive and practical. Dr. Elman has delved into at least six different fields, going over the knowledge which had been built up by research workers over decades, and distilled from them this compact volume. Typifying the ideal modern surgeon, he had had a wide research training and experience prior to entering the specialty of surgery and has been a prodigious worker in one of the sectors of this field, the new and important sector of intravenous amino acid alimentation. He has made important and basic contributions in this sector and, indeed, should be credited with bringing it into practical clinical use. He is, therefore, eminently qualified to write such a book, and it is doubtful whether, in the hands of any other author, it could have been so lucidly and effectively written.

The book is well organized, skillfully integrated, written in a highly readable style, and presented in a well-balanced manner. It is brief without sacrificing scientific exactitude and scholarship. As is to be expected, the best chapters are those in the field of the author's major research competence—the protein field; but the chapter on water and electrolyte needs is also excellent. That on the history of intravenous therapy is interesting and illuminating, and the extensive field of vitamin therapy, which would appall others, has been skillfully packed into 11 pithy pages. The chapter on the practical program of intravenous alimentation, which climaxes the book, is practicable and highly instructive. The cases used as illustrations are well chosen, as are also the charts and figures, which are clear, easy to grasp, and well reproduced. Furthermore, the book is well documented, covering some 450 papers by over 500 authors. The extensive bibliography, culled with such painstaking care from a field which must number publications by the thousands, should prove exceedingly valuable to the more serious student.

Dr. Elman must be congratulated on rendering the clinical fields a threefold service: first, in bringing clarity, order, and organization into a confused field; second, in giving a demonstration, to use the words given in the preface of the book, on "how advances in surgery frequently have emerged in fields entirely outside surgery itself," and third, in exemplifying in his own professional life how this can be effectively brought about.

Co Tui

477 First Avenue, New York City

The human ear in anatomical transparencies. Stephen L. Polyak, Gladys McHugh, and Delbert K. Judd. Elmsford, N. Y.: Sonotone Corporation, 1946. (New York: T. H. McKenna, distributors.) Pp. 136. (Illustrated.) $10.50.

This work is unique in that it is a joint product of an anatomist, a medical artist, and an otolaryngologist; it is novel in its technique of transparent illustrations which, for the most part, are excellently performed; and it is ambitious in the attempt to analyze the ear from the standpoints of ontogenesis, phylogenesis, morphology, and function and to present the material in a form useful to interested laymen, scholars of speech, scientists, and medical specialists.

The book is in two parts. The first, which is general in scope, consists of five chapters. Chapter 1 deals very briefly with the chief functions of the ear, hearing and equilibrium, and their phylogenesis. Chapter 2 outlines very simply the constituent parts of the ear. Between Chapters 2 and 3 is a set of transparencies consisting of 12 beautifully colored drawings of serial dissections of the right side of the head which, when superimposed on each other, give a composite picture of the dissected head showing considerable depth. Chapter 3, is essentially an anatomical atlas of the head, designed to show the topographical relationship of the ear to the rest of the structures. It is fortified with 14 colored plates of dissections at various levels. The text, besides presenting anatomical description, stresses functional and topographical relationships. Chapter 4 presents a careful anatomical and functional description of the larynx and is well illustrated in color with views of 11 dissections, 4 laryngoscopic views, and other diagrammatic aspects. The text is partly descriptive but is written largely from the standpoint of the student of speech. Chapter 5 is a lengthy account of the anatomy and function of the external ear, and the abundant illustrations depict both the ontogenetic and phylogenetic development.

Part II consists of Chapters 6, 7, and 8, which present a more detailed anatomical and functional description of the middle and internal ear. Chapter 6, like Chapter 3, is a topographical descriptive atlas, but includes only the more limited area of the ear. Whereas the illustrations in Chapter 3 are life sized, those in Chapter 6 are magnified 3 ×. Just preceding this chapter there is a group of 8 transparencies depicting serial dissections of the region of the internal and middle ear at a magnification of 3 ×.

The colored drawings, both in the transparencies and in Chapter 6, are very well done and the views well chosen. The text is a conventional account showing nothing new.

Chapter 7 deals with the microscopic anatomy of the internal ear. The test here is also a conventional account. The illustrations taken, for the most part, largely from classical textbook figures, are augmented by drawings from sections of the ear of *Macaca rhesus* and from Golgi preparations showing nerves and nerve terminations from various animals.

The final chapter is concerned with the functions of the middle ear and internal ear. Although various theories regarding the function of the middle ear are cited, the question is left open. However, in the case of the cochlea the authors lean very strongly to Helmholtz's theory.

The book is very readable and, with the numerous unique but splendid drawings, should be of interest to the layman as well as to the scientist.

T. H. Bast

Department of Anatomy, The University of Wisconsin

Ophthalmology in the war years. (Vol. 1.) Meyer Wiener. (Ed.) Chicago: Year Book Publishers, 1946. Pp. x + 1166. $13.50.

Meyer Wiener, together with an imposing number of associate editors, has produced a volume which reviews all obtainable literature in ophthalmology from 1940 to 1943. Such a book was requested by the Subcommittee on Ophthalmology of the National Research Council. It was intended to make available to physicians, who were in the service as well as at home, the great wealth of ophthalmic literature which appeared in the first few years of the war. Over 8,000 articles have been abstracted, and an exhaustive bibliography has been compiled.

The text is printed in large type and on good paper. The basic sciences, clinical and scientific investigations, therapeutics, and surgery have been included. The book has greatest value as a reference volume. Although few sections can be read as a whole with full grasp of the tremendous amount of information digested in the numerous paragraphs, specific knowledge, when sought by topic, may be found concisely and accurately reported. The many pages that have been condensed to a single book enable one to conserve energy and time when searching for information of that three-year period. Those engaged in research will find this volume of tremendous help.

The editor has attempted to assign subjects and sections to appropriately qualified authorities for review and, since the associate editors are also deep students of ophthalmology and men of well-known reputation, one is assured that topics have received expert attention. Some sections have been reviewed in a more interesting fashion than others. Whereas some chapters are simply a succession of paragraphs representing well-reported articles, they do not contain good commentary and evaluation, which the average reader seeks. Other are masterpieces, and one feels that the subject matter has been weighed, sifted, organized, and presented so that nothing is left to be desired.

Noticeably lacking are illustrations and photographs. These would have greatly enhanced the value of the book, not alone to the ophthalmologist interested in writing and research but also to the busy clinical eye physician.

Dr. Wiener and his co-editors deserve an expression of gratitude for the great task which they have undertaken and and completed during such a trying period.

Benjamin Sachs

520 Beacon Street, Boston

Adjustment to physical handicap and illness: a survey of the social psychology of physique and disability. Roger G. Barker, *et al.* New York: Social Science Research Council, 1946. Pp. xi + 372. (Illustrated.) $2.00.

The purpose of this investigation is well stated in the following paragraph from the introductory chapter: "There is a widespread assumption among laymen and social scientists that physique in its social-psychological aspects is of great importance in the motivation of the individual. Among clinical psychologists and psychiatrists there is a great superstructure of theory based upon case studies and clinical experience which assumes that important sources of personal maladjustment lie in the somatopsychological situation of the individual. It is the purpose of this publication to bring together the widely scattered knowledge bearing upon this problem. We propose to raise this question: What is known of the social and psychological significance of physique and in terms of what concepts can the known facts be described and explained?"

The authors do not concern themselves with all the relations between physique and behavior but confine their survey to what is designated as the "somatopsychological problem," *i.e.* the problem of the purely psychological and social significance of physique, or how physique determines behavior. Only those variations in physique considered relevant to the somatopsychological problem are discussed. The criteria of relevancy formulated by the authors are three: (1) The physique must instigate behavior which in turn requires behavioral adjustments not directly induced by the particular physical characteristic in question; (2) the physique must be perceived by the person or others as being of significance for his life career; or (3) the physique must be perceived by the person or others as having social significance in the particular culture.

From a long list of physical variations believed to have somatopsychological significance the authors have excluded age, race, sex, speech defects, and leprosy. This leaves cosmetic defect, muscular strength, motor ability, visual impairments, auditory impairments, tuberculosis, heart disease, diabetes, rheumatism, cancer, orthopedic disability, and acute illness. The authors then undertake to review and interpret the available literature on those topics which represent the more important practical problems as well as the main types of variation in physique, namely, normal variations in physique, orthopedic impairments, tuberculosis, impaired hearing, and acute illness.

Each of the principal chapters attempts to draw out from general analysis those hypotheses and conclusions that appear to be warranted by the available research. Each chapter concludes with one or more "research summaries" of the most important studies bearing upon certain topics considered in the general discussion. One special chapter discusses the employment of the disabled. This is primarily a review of the more general literature on the problem and supplements the discussions of employment presented in the more specialized studies considered in the preceding chapters.

It is a little surprising that only incidental attention is given to visual deficiencies. Seriously limited vision would seem to meet one or more of the authors' criteria of relevancy and to be among the "more important practical problems."

Following the main body of the report are 52 pages of bibliography, divided into two sections. The first includes studies considered in developing the analyses and interpretations of the special topics included in the book itself; the second, bibliographies on physical variations not specifically treated, e.g. visual disability, cardiac disability, diabetes, cosmetic defect, rheumatism, and cancer.

It is obviously impossible to state a brief general conclusion to which this volume leads. It is reasonably clear, however, that the authors have demonstrated the truth of a statement made in the preface, namely, that "the state of our knowledge of these matters (*i.e.* the somatopsychological significance of variations in physique) is little above the level of folklore in many respects . . . ," and that a very large superstructure of practical action in such areas as occupational therapy, industrial employment policies, hospital organization and administration, industrial accident legislation, and vocational rehabilitation has been based upon this limited knowledge. The authors also show that promising and valid techniques are available for the study of problems of great practical and theoretical importance in this field. Both for its bringing together in one place a considerable mass of material and for its suggestive and thought-provoking analysis and interpretation the volume will be extremely useful to any individual or group proposing either to undertake additional studies of the significance of physical variations or to formulate policies and plans for the practical affairs of daily life.

W. B. FEATHERSTONE

Teachers College, Columbia University

A psychology of growth. Bert I. Beverly. New York: McGraw-Hill, 1946. Pp. 200. $2.50.

When a physician writes a book on psychology, he is likely to get into difficulties similar to those which would probably be encountered by a psychologist attempting to write a book on medicine. There are many evidences of this in *A psychology of growth.*

The portion of the book dealing with the practical aspects of behavior problems is accurate and valuable, although in this reviewer's opinion far too much emphasis is placed on the pathological conditions. It is, of course, understandable why that emphasis would appear in a book by a physician written for nurses. But the psychology of the author is neither accurate nor up to date and in many cases is inconsistent. At times he writes like a Watsonian behaviorist, at times as a Freudian, and throughout his discussion displays an unusually strong prejudice toward the influences of heredity.

While in general he gives helpful suggestions for dealing with behavior problems, at times he fails to do so. For example, we are told: "In addition to acquiring food, sucking provides an emotional satisfaction. That is the reason why all babies suck their thumbs and they should be allowed to do so." Almost no suggestions are given, however, concerning means of providing such emotional satisfactions that the infant will not suck his thumb, and the question of diet as one cause of the action and the malformation of teeth as one result are apparently not considered important. Again, the reader is warned that there should be skillful supervisors on the playground because "homosexual practices which cause great distress in later life can start with childhood play." However, in the following sentence is the statement: "The supervisor who finds children engaging in sex experiments should not become perturbed because such a reaction can create disturbances in the minds of the youngsters." No suggestion whatever is made as to what the supervisor should do if he discovers homosexual practices, and the reader is left with the implication that a person should not be disturbed concerning a practice which may cause great distress in later life.

As has been suggested above, there are many errors of fact when the writing touches directly the field of psychology. The statement that "two-year-olds are able to distinguish black from white but do not distinguish between colors" indicates a clear lack of information of researches in child psychology. Similarly, the statement in more than one place in the book that abstract thinking does not begin to develop before the age of 12 is clearly out of line with the evidence. Indeed, Beverly misquotes the Stanford revision of the Binet scale in supporting his statement. It is true that on the tests definitions of abstract words are called for at age 12, but the doctor did not look back to see that on Form M there is also such a test at age 10 and on Form L at age 11. Of course, there is all sorts of evidence to show that abstract thinking begins to develop very much earlier than these ages. On the subject of intelligence and intelligence tests there are also many errors. An outstanding example is the statement that the 1908 Binet-Simon tests "consisted of six tests for each year from three to eighteen." This instrument consisted of 5 tests for each year from 3 to 10, a 12-year test, a 15-year test, and a very imperfectly standardized adult test. Still again, very few psychologists working in the field of school subjects will be happy at the statement that "spelling, reading, and writing difficulties are usually innate." There is evidence that this is not the case. Neither does the best evidence agree that "because of their rapid growth adolescents fatigue easily and have poor motor coordination."

Indeed, there are so many inaccurate or misleading statements that it would seem distinctly unwise to recommend this book, despite its many good features, as one which could be used in any class in psychology.

D. A. WORCESTER

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Human factors in air transport design. Ross A. McFarland. New York: McGraw-Hill, 1946. Pp. xix + 670. (Illustrated.) $6.00.

The main thesis of this book, according to the author, is to demonstrate the importance and need for studying human factors which should be considered in the design and operation of air transports. With remarkable attention to detail and with the aid of numerous tables, graphs, charts, diagrams, and pictures, Dr. McFarland has presented a large portion of the work which has already been done in this field. The presentation is not confined to a discussion of the medical, physiological, and psychological studies which have been made, but also includes detailed discussions of design and engineering features relevant to the human factors involved.

The subject matter has been divided into 10 parts, each with its own chapter, as follows: (1) "High-Altitude Operation and Pressurized Cabins," (2) "The Control of Ventilation, Temperature, and Humidity," (3) "The Control of Insects and Air-borne Diseases," (4) "Carbon Monoxide and Other Noxious Gases," (5) "The Control of Noise in the Cabins of Aircraft," (6) "The Control of Vibration in Air Transport Planes," (7) "Acceleration, Motion, and Flight Performance," (8) "The Cockpit and Control Cabin of Air Transports," (9) "Passenger Accommodations," and (10) "The Prevention of Aircraft Accidents."

This is a book written by an expert in one field (aviation psychology and physiology) for the use of experts in related fields (aeronautical engineering and airline operation). It has an extremely broad scope, and it would be difficult to name many relevant problems which are not included. Yet, because he was writing for engineers, the author evidently felt obliged to present the material in as concrete and specific form as possible. As a result, many research findings assume a more definitive and authoritative form than would be granted them, perhaps, by other biological scientists. Dr. McFarland is careful to point out where inadequacies of this sort exist. Even where generalizations are not wise, the data have been presented in minute detail—a form of presentation which overemphasizes the significance of the findings.

In spite of this practice there is no doubt concerning the value of the book for anyone, including the biological scientist, who is working in this new field. For aeronautical designers and airline operators it should become required reading. As the author points out, "until aircraft can be flown completely automatically, the human element should be considered as an integral component. A truly functional design will be achieved only after it is thoroughly realized that the crewman (and passenger) is as much a part of the plane as any structural or mechanical feature." Too often the problems arising from human factors in design and operation have been settled by "a majority vote of those sitting in judgment" without recourse to experimentation or even systematic observation. Dr. McFarland has offered ample evidence that when research by competent investigators replaces solutions based on opinion, the reward in terms of human safety, efficiency, and comfort is great.

A. C. WILLIAMS, JR.

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Indians before Columbus: twenty thousand years of North American history revealed by archaeology. Paul S. Martin, George I. Quimby, and Donald Collier. Chicago: Univ. Chicago Press, 1947. Pp. xxiii + 582. (Illustrated.) $6.00.

Modern archaeology in the United States may be said to have begun about 1912 with Nelson's percentage stratigraphy in the Galisteo Basin, New Mexico. Since that date the authors of *Indians before Columbus* are the first to tackle the job of systematizing the net gains of North American research archaeology over this 35-year period.

At the outset let the reviewer go on record as being in favor of this book. It totals up as a good one. It has no competitors, and in this circumstance it has all the advantages and hazards of being a "first." The book is a sound stocktaking of what professional archaeology has to offer as basic data for America north of Mexico. On the whole, the material presented is as up to date as it was possible to make it.

Indians before Columbus is written, say the authors, for the interested layman and the beginning student and is not intended for a general professional reference. In spite of this, it is a useful book for every archaeologist to own. The three short introductory chapters, which are eminently successful, explain to the uninitiated what archaeology is, what is known concerning the origins of the American Indian, and the truth behind a number of common popular fallacies concerning the American Indian. Chapters 4 through 9 take up, in order, the arts and industries by which the Indians are chiefly known to the archaeologist: stone, copper, bone and shell, pottery, basketry and cloth, and trade and commerce. A clear picture of the technologies involved, the degree of mastery of each, and integration and significance to a preindustrial economy is presented to the reader. The actual archaeology deals first with the earliest Indian inhabitants of North America as represented by the Folsom, Yuma, Sandia, and Cochise finds. An attempt is made to demonstrate possible intermediate horizons between these early lithic cultures and pottery-agricultural periods. A treatment of the later periods follows a fourfold areal division into (1) Southwest, (2) eastern North America, (3) Pacific slope, and (4) Far North, or Eskimo. Each of these major areas is again divided into several regions.

Criticisms are of two kinds: (1) of specific points of fact in sequential-distributional information or interpretation, and (2) of presentation and broader interpretation. Specifically, in the discussion of the Hohokam culture of the Southwest the chronology used follows Gladwin's earlier, rather than his more recent, estimates, but there is no reference to this point. In discussing the southeastern "Death Cult," Krieger's recent but radically different interpretation is not taken into consideration. In Georgia there is no substantial evidence for burial mounds in the Deptford period. The chronological position given for the Florida Crystal River culture is highly debatable. In southern Louisiana the Troyville period is put in the Burial Mound rather than the Temple Mound stage. This tends to obscure the important fact that the temple mound-plaza arrangement complex had its first appearance in the Southeast at this relatively early date, notwithstanding its association in the Troyville period with Marksville-Hopewell style pottery.

On a more general level, the book loses a great deal of its force as an introductory popular book by its failure to follow through on interpretations of cultural process. If the book is for the general reader, and if the book is to hew to the line of one set of historical interpretations—both avowed purposes of the authors—then certainly it should go further beyond the time-space cataloguing of cultural data than it has. For example, at several places in the discussion of the eastern United States we are taken right up to the point of what should be the pay-off reward for all this archaeological grubbing, only to be anticlimactically dropped. In speaking of the decline in craft arts in the late prehistoric periods in the Northeast, the authors make this interesting statement but go no further: "Thus there is a decline in terms of material remains, but this decline probably is not real. Certainly the improvements in the economy (agriculture), the possible social changes, and the probable lack of the need for tools and industries of the past mark a type of climax or florescence that cannot be grasped by archaeological techniques" (p. 258). But what does this technical and aesthetic decline, just preceding the historic horizon and also remarked upon again and again in several other subareas of the East, imply in social terms? With a minimum of inference from ethnography the lacunae of archaeology can be filled to show the late prehistoric period as the time of rising political confederacies and war alliances in the Northeast. These must, inevitably, have been the result of mounting population pressures correlated with the improved agricultural production so characteristic of the late prehistoric era all through the East. With the necessitated shift to organized war patterns the old religious emphasis of the East, much of it centering around the burial cult and its associated craft goods, disappeared. At least, this is one explanation, for which there is considerable supporting evidence, that the average reader might hopefully expect in a general book on the rise and growth of American Indian cultures.

GORDON R. WILLEY

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Trinidad village. Melville J. and Frances S. Herskovits. New York: Alfred A. Knopf, 1947. Pp. viii + 351. (Illustrated.) $4.75.

This book is a worthy contribution to two phases, among others, of the study of human culture: It represents a workmanlike addition to the slowly accumulating literature of "modern," as opposed to "primitive," ethnology; and it demonstrates the intricate interweaving of African and European traits which is the result of the acculturation process in so many Negro groups of the New World.

The Trinidad village in question is Toco, at the extreme northeastern end of the island, and the population is almost entirely negroid. The community is rather isolated in terms of effective contacts with outside centers of cultural diffusion, and as a separate entity it is relatively new, having been settled for the most part within the past 50 years by people coming from other parts of Trinidad and Tobago. In these respects Toco offers a situation in which the immediate historical factors, if not "controlled," are at least known and assessable, which is an advantage in analyzing the dynamics of custom integration and social organization, while it also exhibits to a degree the cultural homogeneity of custom and physical type which is characteristic of peasant and folk cultures generally.

The field work was undertaken in 1939 as part of a long-term project with which the Herskovits name has been associated for some 20 years, namely, the study of the various adaptions in the New World of Negroes whose ancestors were transplanted from Africa in slavery. The differential stripping, retention, and reinterpretations of African cultural elements in the American setting is the center of interest in this book. As the reworking of native African culture is better understood, contributions to the general theory of cultural change are offered.

Using the concept of "cultural focus," the authors demonstrate that most of the formal aspects of African culture, including the institutional structure of social organization and religion, have disappeared in Toco. Yet, many of the basic orientations, particularly in family arrangements, religious groups such as the Shouters, witchcraft, the persistent power of ancestral spirits, etc., come directly from the African systems. In Toco they are in many cases so embedded in a matrix containing elements from other sources as to be unidentifiable to the casual observer. Nevertheless, such identification and understanding is a prerequisite to scientific analysis and prediction of the actual behavior of the people. The problem of Toco has its parallels not only in numerous other Negro communities of the Western Hemisphere, but also among the millions of persons in Latin America who practice a mixed culture, derived from indigenous Indian, colonial Iberian, and modern European sources.

The semipopular style presumably required of a commercially published report makes for relatively smooth reading, at the expense, however, of the omission of details of method and data which would be of interest to specialists. The latter type of material will doubtless appear in more technical publications.

JOHN GILLIN
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Fossil vertebrates from western North America and Mexico. E. L. Furlong, *et al.* (Contributions to Paleontology, Publ. 551.) Washington, D. C.: Carnegie Institution of Washington, 1946. Pp. iv + 195. (Illustrated.) $2.50, paper; $3.00, cloth.

The latest volume of Contributions to Paleontology covers the years 1943–46 and includes eight articles on fossil fishes, birds, and mammals.

Three papers by Lore Rose David, entitled "Use of Fossil Fish Scales in Micropaleontology," "Some Typical Upper Eogene Fish Scales from California," and "Upper Cretaceous Fish Remains From the Western Border of the San Joaquin Valley, California," demonstrate the use of fossil fish scales in stratigraphic correlation and in paleoecology. This author states that it is nearly always possible to recognize families, genera, and often species on the basis of differences in scale sculpture—a point that might be disputed by some ichthyologists. The recognition of characines, for instance, in marine Upper Cretaceous deposits, is of considerable importance if the scale identifications are certain.

"A Review of the Pleistocene Birds of Fossil Lake, Oregon," by Hildegarde Howard, is a well-documented account of all the known bird remains from this rather famous Upper Pleistocene locality. Although there is a general resemblance between the avifauna of this deposit and that now living about the fresh-water lakes of Oregon and California, interesting examples of subspecific differences are present which indicate subdivisions of a chronocline. Unexpected members of the fauna include a flamingo and a jaeger.

The history of the badgers in North America has been greatly clarified by E. Raymond Hall in a contribution entitled "A New Genus of American Pliocene Badger, With Remarks on the Relations of Badgers of the Northern Hemisphere." The new genus, *Pliotaxidea*, is based on skull fragments originally referred to *Taxidea* and a recently discovered skull from Oregon, all of Pliocene age. It is now apparent that the Asiatic and American badgers have been separated since possibly the Upper Miocene, with *Pliotaxidea* close to the *Taxidea* line and *Parataxidea* of the Asiatic Pliocene close to the ancestral stock of *Meles*. There is no evidence of intercontinental migration within this subfamily subsequent to the early Pliocene.

To the nonspecialist, at least, the taxonomy of the North American fossil antilocaprids presents a rather confusing picture. This is due partly to the difficulty of differentiating true taxonomic characters from those associated with age and sex, and this problem is evident in a paper by E. L. Furlong, "The Pleistocene Antelope *Stockeros conklingi* From San Josecito Cave, Mexico." The exact distinction between *Tetrameryx* and *Stockoceros* is not completely clarified, although the author states that "*Stockoceros* is at least subgenerically distinct from *Tetrameryx*." A second contribution by the same author deals with the "Generic Identification of the Pleistocene Antelope From Rancho La Brea." This antilocaprid is removed from the genus *Capromeryx* and is assigned to the new Pleistocene genus *Breameryx* on the basis of apparently distinguishing dental and skull characters. It would appear that the antilocaprids offer a very fertile field for quantitative taxonomic study.

"A Miocene Mammalian Fauna From Beatty Buttes, Oregon" is described by Robert E. Wallace. The assemblage is probably Upper Miocene (Barstovian) and presumably includes grassland and woodland forms such as *Merychippus* and *Dromomeryx*. It is very similar to that found at two other Upper Miocene localities in Oregon, Sucker Creek and Skull Springs.

BOBB SCHAEFFER
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Mammals of eastern Asia. G. H. H. Tate. New York: Macmillan, 1947. Pp. xiv + 366. (Illustrated.) $4.00.

The new volume in the Pacific World Series represents exactly the type of handbook that should have been available to the personnel of the U. S. forces in China during the war, and thus exactly the need the series was designed to meet. Dr. Tate was co-author with J. E. Hill and T. D. Carter of *Mammals of the Pacific world*, which described the mammals of the Pacific and Australasian islands, and the two volumes form much the sort of naturalist's Baedeker for which we may hope there will be a continuing demand. The production of such volumes is one of the duties of naturalists and one of their functions that deserves active support.

In a brief introduction the mammals as a zoological group are presented to the nonzoological reader, some account of their adaptations to the conditions of existence are given, and the use of scientific names is explained. A glossary at the end of the book supplements this chapter.

A second general chapter, which is an essay on the geography of eastern Asia, interestingly sets forth one of the two frames of reference of animal geography, namely, the climatically dominated ecological-vegetational matrix in which animals find their most obvious natural associations of range. The reviewer has elsewhere been occupied at length with the subject of ecological animal geography, and it is gratifying to have this kind of introduction to the systematic account of the mammals.

The systematic account occupies 325 pages of the book. This forms a most accessible account of some of the more strikingly unfamiliar types of mammals. The insectivores include the tree shrews (now commonly placed with the primates), the hedgehogs and some of their primitive relatives, and a wealth of moles and shrews; the bats are extremely varied, including both the fruit-eating and insectivorous suborders and six families; the pangolins, or scaly anteaters, are represented by two types; the flying lemur occurs in the more southern parts of the territory considered; the lemurs are represented by the slow lorises; there is a large variety of monkeys; and the gibbons represent the higher tailless apes. The carnivores range from familiar furbearers in Siberia, belonging to well-known American types, to the remarkable lesser panda and giant panda (which are apparently related in name only) and the great variety of civets and mongooses, which are quite unfamiliar to American zoologists. The account of the whales is limited to the forms that enter fresh water, including, of course, the peculiar isolated pigmy dolphin of Tung Ting Lake in China. The rabbits and hares are treated as an order distinct from the closely allied rodents proper, and this draws attention to the presence of a variety of montane pikas closely related to those of the western mountains of North America; the rodents proper include such familiar American genera as *Citellus*, *Marmota*, and *Eutamias* and many others, which calls further attention to the zoological resemblances between North America and Asia. The elephant group is represented by the Indian elephant, which ranges eastward to Indo-China; the aquatic coastal dugong, related to the American manatees, forms one of the most distinct of the orders; the list of even-toed ungulates includes tragulids, pigs, wild cattle, goat-antelopes, true antelopes, sheep and goats, and a wealth of deer; and finally, the odd-toed ungulates are represented by the Malay tapir and three types of rhinoceroses.

Any account of the mammals of eastern Asia necessarily leans heavily on the two large volumes on the mammals of China by the late Glover M. Allen. Because of its bulk the latter work is, however, wholly unsuited to field use, and we are fortunate to have Dr. Tate's handbook-sized work. The illustrations are in general excellent. A curious vagary of typography is the capitalization of the most familiar animal group names, such as Bat, Cat, Wolf, etc., together with the common names in general. This is entirely contrary to modern zoological practice, as may be seen by reference to the *Journal of Mammalogy* or Webster's *Dictionary*.

The high price of this book, as well as of the trade edition of the Pacific World Series in general, most unhappily limits the dispersion of these introductions to natural history at the levels where they would be most useful.

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A review of the North American species of Philanthus, north of Mexico (Hymenoptera: Sphecidae). R. W. Strandtmann. (Graduate School Studies. Conti. in Zoology and Entomology, No. 7) Columbus: Ohio State Univ. Press, 1946. Pp. 32. (Illustrated.) $2.50.

From a study of 5,500 specimens of these common wasps, Dr. Strandtmann has achieved a taxonomic analysis of the genus within the area selected. The biology, to which no contributions are made, is reviewed in a single page, and no other topics are discussed.

The well-drawn figures, both of the entire wasps and of morphological details, are pleasing. The presentation of distributional data, mostly only by state, is inadequate. From 100 to 1,200 records of each of the 7 most numerous species would have afforded a real basis for an analysis of their zoogeographic affinities and quantitative distribution—the inescapable responsibility of every taxonomist reviewing a group from adequate material.

Counting "*hirticulus*" as the male of *bicinctus*, there are 22 species, two still known from only one sex. Thirteen of these occur only west of the Mississippi, 3 are ubiquitous, 1 is Floridian, and the remaining 5, with the normal pattern of northern species, inhabit more or less of the Northeast (in one instance, entire East) and prairie and mountain states. Five species are little known, represented by 5 specimens or less, 5 by from 6 to 25, and 5 more by under 100. Of the remaining 7, three of the four represented by over 500 individuals are ubiquitous, and the fourth is widespread over the West.

The species *politus* is divided into 9 subspecies. One occupies the territory east of and including the states bordering the west shore of the Mississippi River. The others are all west of that river and, except for texana, are an aggregate of geographically intermingling forms that seem to present no basis for designating subspecies rather than variants. At least they demand a very much more detailed geographical analysis.

It is a satisfaction to see that the author has disposed of many of the unnecessary trivial names that have cluttered past literature. Yet a little time spent in correspondence could have disclosed the identity of *barbatus* Smith, *crabroniformis* Smith, and *multimaculatus* Cameron. When this has been done, we may anticipate further nomenclatorial changes.

J. C. BRADLEY

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Forest soils and forest growth. S. A. Wilde. Waltham, Mass.: Chronica Botanica; New York: G. E. Stechert, 1946. Pp. xx + 241. (Illustrated.) $5.00.

This is the first textbook on the subject of forest soils to appear in the American literature. It represents a scholarly attempt to cover the broad fields of soil science with emphasis on soil as a medium for the growth of forest trees.

In brief, the book might be considered as a monograph on forest soils of cool-humid climates with special emphasis on the management of forest nursery soils of the Lake States. The author's familiarity with the European literature, particularly the Russian, has resulted in the unnecessary use of many foreign terms to describe conditions which have already been acceptably described in the American literature. Examples of this are the use of the terms *melanization* for incorporation of humus, *melanized* horizon for the conventional A_1 horizon, *grood* soils, and *charral* soils.

As in many books, general statements are made which, if important, should be substantiated by quantitative evidence rather than by the citation of references from which they were derived. An example of this can be found on page 65: "In general, soils with a low content of fine soil material, *i.e.* sandy soils, support only trees which have low requirements for moisture and nutrients, such as pines, scrub oaks, white birch, and aspen. On the other hand, soils with a high content of fine particles, *i.e.* loam soils, support trees which have high requirements for moisture and nutrients, such as species of spruce and fir, hard maple, basswood, elm, and white ash (Haig, 1929; Scholz, 1931; Coile, 1935; Hosley, 1936)." The work of at least two of the authorities cited (Haig, 1929, and Coile, 1935) contained little, if anything, to verify the statement as made.

In a number of places the author speaks of "plant food" in the soil. Since plant food is manufactured in the plant through the process of photosynthesis, it is apparent that the author means "plant nutrients" when he speaks of "plant food."

Silvicultural terminology is confused where the term "selective logging" is used as a synonym for the selection system of cutting.

Chapter XII, "Productivity of Forest Soil and Forest Management," is an elementary treatise on what is commonly known as forest regulation and valuation. This information can be found in any textbook on forest management. Entirely lacking is the wealth of information available in the American literature on the relationship between soil properties and site index, rate of growth, and the composition of forest stands.

The last five chapters are concerned with forest nursery soil management. The management practices outlined are particularly adapted to the Lake States region, where they were in the main developed.

T. S. Coile

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Forest soils. Harold J. Lutz and Robert F. Chandler, Jr. New York: John Wiley; London: Chapman & Hall, 1946. Pp. xi + 514. (Illustrated.) $5.25.

This book is a very welcome addition to the literature in a relatively new field of applied science in this country. Prior to 1946, material on forest soils was available only in journal articles and foreign language works. American and English texts on soil science are usually written for either the agricultural student or the pedologist (one who studies the soil and its development as a natural phenomenon without regard to its usage). The reader has only to compare the subject matter listed in the indexes of these books with that given in *Forest soils* to appreciate the inadequacy of the former works for foresters.

The thoroughness of coverage is shown by the chapter headings, which include: soil-forming minerals; soil-forming rocks; disintegration and decomposition of minerals and rocks; forest-soil organisms; the organic matter of forest soils; nature and properties of soil colloids; general physical properties of forest soils; the water relations of soils, particularly forest soils; general chemical properties of forest soils; soil formation; forest-soil classification; soil erosion and forest-soil deterioration.

The fundamentals of soil science are stressed, and much of the material is presented in considerable detail with no attempt to simplify for the reader who is not fortified with a scientific background. The treatment of the basic structure of minerals and the mechanics of base exchange, to cite two examples, will be much too technical for many readers. Students in a one-semester course who have not had adequate courses in geology and chemistry will find such portions of the text rather heavy going.

On the other hand, it is a decided advantage to have a book which contains these fundamentals of soil science as they relate to the particular subject—forestry. Recourse to other soils texts will not be necessary unless the student is specializing in a particular phase of the subject. This book will serve as an excellent reference work, and instructors of general soils courses will find it very useful because it approaches the subject from a somewhat different angle than is customary in soils texts.

In one rather specialized branch of the subject—nursery soils—treatment is much too brief to be of use to managers of forest nurseries. The authors undoubtedly preferred to leave that field to others.

Literature citations, which are abundant, are given at the end of each chapter. The text is illustrated with about 33 half tones and numerous well-chosen charts. Several minor changes, such as inclusion of a more up-to-date soil textural class chart than that shown on page 232, and the words "dissolved matter" in the title of Table 5 on page 72, will undoubtedly be made in subsequent editions.

The authors are to be congratulated on the production of this excellent volume, which will take its place along side older, well-known works of European investigators.

Herbert A. Lunt

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General horticulture. Thomas J. Talbert. Philadelphia: Lea & Febiger, 1946. Pp. 452. (Illustrated.) $4.00.

This book serves producers of horticultural crops and vocational and undergraduate students in schools and colleges with general information on the production and handling practices for a wide range of horticultural crops. It serves primarily the interests of students and growers of tree fruits, small fruits, and nuts in temperate climates. An over-all picture of the entire horticultural industry in the United States is given to show the production areas and relative importance of fruits, nuts, vegetables, flowers, ornamental plantings, and forestry. The reader is also introduced to the more important subtropical and tropical fruits, with pertinent comments on their cultural requirements. The last chapter gives a broad introduction to the practices involved in harvesting, handling, and distributing horticultural crops.

The printed pages are interestingly broken with 129 unusually clear illustrations which have been selected with painstaking care by the author to emphasize important practices and objectives. Most of these engravings are "close-ups," particularly as they are used to illustrate insects and diseases, their injuries, and single-step procedures used in planting, budding, grafting, pruning, and training.

At the close of each of the 21 chapters, selected references of books, bulletins, circulars, and scientific papers are listed to enable the student to give additional time to the study of specific areas in line with his interests.

Separate chapters are given to pome fruits, stone fruits, grapes, strawberries, cane and bush fruits, nut trees, vegetables, beautifying the home grounds, and tropical and subtropical fruits. Chapter I is appropriately devoted to a discussion of the horticultural industry, and the following 10 chapters develop subjects which broadly interrelate with all fruits, such as fruitfulness, pollination, thinning, propagation, soils and sites, planting procedures, soil management, use of fertilizers, pruning, insects and diseases of fruit crops, and their control by spraying and dusting.

Students whose major interest is in fruit growing will find in this book a comprehensive introduction to general horticulture, written in a style that is clear cut, forceful, and most helpful in acquiring a knowledge of sound horticultural practices.

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Since the end of the war a number of books published abroad have been sent to the Science office for review. The following reviews cover some of the most recent of these. Future issues will contain reviews of others as they are received.

Synthetische Methoden der organischen Chemie. W. Theilheimer. Basel-New York: S. Karger, 1946. Pp. viii + 224. Fr. s. 25.

This is a unique reference book in synthetic organic chemistry. It does not contain detailed directions for selected preparations as does *Organic syntheses*, nor does it present exhaustive discussions of single reactions after the manner of *Organic reactions*. Instead, the author endeavors to supply information to the chemist who wishes to achieve a certain result. The basic idea is that few really new reactions have been developed in the past 10 years, but much has been done in the way of improving old ones. There is no quick way of gathering from the literature the hopelessly scattered bits of information relating to classical, as well as little-known, procedures, and the author has done much to supply this deficiency. The present volume is the first of a series and covers the years 1942–44.

The arrangement is new and frankly experimental. Reactions are grouped according to the bond formed. In the symbolism used, the new bond is first indicated; this is followed by a device to show the nature of the reaction, such as addition, rearrangement, substitution, or elimination; anP last is the element involved in the reaction. Thus, CH$\uparrow\downarrow$O means the formation of a CH bond by replacement of oxygen as in the Clemmensen reduction or hydrogenolysis of an alcohol. Elements follow the Beilstein sequence except that carbon comes last, and the rule of last possible placement is followed. The system appears confusing at first, but with a little use its reasonableness is evident. An edition for American students would be more useful if there were an insert containing an English guide to the system, with a few examples.

There is a generous alphabetical index which lists named reactions as well as types of compounds, whether they appear as starting materials or as end-products. Most reactions can be located through the index without use of the system.

The choice of references is satisfactorily broad in spite of wartime difficulties. Fifty, chosen at random, showed the following distribution: German, 21; American, 13; British, 8; Swiss, 6; others, 2. References to Russian literature are rare.

The book will be helpful to the advanced practitioner, as well as to the beginner who is completely lost when faced with the problem of finding how to carry out a strange reaction. It will be a fertile source of ideas, for the unique arrangement brings reactions together according to the end achieved; consequently, in looking up a procedure the reader will often be surprised to find many new ways to accomplish the same result. As a rule, original papers must be consulted, but most of these are in readily available journals.

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Actions of radiations on living cells. **D. E. Lea. Cambridge, Engl.: at the Univ. Press; New York: Macmillan, 1946. Pp. xii + 402. (Illustrated.) $4.50**

This book deals with a field which is now the center of wide interest from many sides and the object of much work, and which is particularly appealing in that it has appeared to many as a principal pathway for investigating the basic phenomena of life. The book responds to a clear need and should be generally used for study and reference in the field of radiation biology.

The work is aptly described by the author's own words, which appear in the preface: "This book gives an account of certain of the simplest and most fundamental actions of x rays and other ionizing radiations on living cells. It does not survey the whole field but deals chiefly with the mechanism of those actions of radiation which are well enough understood at present to allow a detailed discussion. The relevant physical properties and chemical effects of ionizing radiations are first described, and then the bulk of the book is occupied by the effects of radiations on viruses and on the genes and chromosomes of higher cells. In the concluding chapter the killing of cells by radiation is discussed. Extensive numerical data concerning the dissipation of energy in tissue by various radiations are given. The book is of importance for medical, genetical and biological investigators and for physicists interested in biology."

The reviewer is very sympathetic toward this program and especially appreciates the stress laid on those radiobiological effects which, in a physicist's language, may be termed "elementary." Carrying out this program was an important and laborious task which has been capably and successfully discharged. Quantitative data and literature references are plentiful and well organized. Much space is devoted to a deep and detailed theoretical analysis of the experimental material, including important contributions by the author, some of which are first published here. Therefore, the reading may require considerable effort, but not an unduly great one, as the exposition is remarkably clear.

The reader still unfamiliar with radiobiology should bear in mind that different authors have frequently held widely different opinions on the significance of whatever evidence was available in this field. Even though such divergencies have become less acute in recent years, the book represents Dr. Lea's personal evaluation of the evidence. Accordingly, it is natural that a number of items in the book may not be acceptable to other workers in the field. Thus, for example, this reviewer is not satisfied with the analysis of the recessive lethals in *Drosophila* (pp. 157 ff.). (This matter will be discussed more fully in a future issue of *Science*.)

The author has wisely intended to keep mathematical detail in the background of his theoretical analysis. However, he might well have gone further in this direction by eliminating the quantitative treatment entirely whenever the experimental evidence warrants only broad qualitative statements. This applies, for example, to the analysis of the dominant lethals in *Drosophila* (pp. 164 ff.), in which a specific working model is treated mathematically in great detail; later remarks show awareness of the difficulties met in applying the model, but the over-all impression conveyed to the reader does not seem quite fair. A similar comment may apply to the recurring unusual practice of presenting numerical data with several significant figures where errors of the order of 10 per cent or more are expected; the insertion of occasional cautioning statements or the possible convenience for numerical work do not seem adequate justifications.

The book contributes to pure as well as to applied physics through very extensive and laborious new calculations on the distribution of radiation energy throughout matter. The author's emphasis on recognizing and analyzing the role played by secondary electrons in this process represents an important advance. As stated in the appendix, the calculations are based on somewhat tentative theoretical assumptions; the eventual influence of these assumptions should be estimated when utilizing the numerical results. The author emphasizes that the energy of photo- and recoil-electrons released by x rays of 10–100 KeV is far from proportional to the x-ray voltage; however, what is important for application is the apportionment of the total x-ray energy among electrons of different energies rather than the apportionment of all the electrons among different energy ranges. The latter is represented by the "mean energy" given in Table 3 of the book. The former is represented by a "weighted mean energy" calculated by giving each electron a "weight" proportional to its energy and is much more closely related to the x-ray voltage.

This book is timely, useful, and important and is recommended for widest circulation; judgment should be exercised, however, in utilizing its content.

The book was completed in the middle of 1944 and became available in England early in 1946. Commercial arrangements prevented its distribution in America until a year later. While the former delay may be charged to war conditions, the latter is highly regrettable.

U. Fano

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Fisica nucleare: dalla pila di Volta alla pila atomica. Plinius Campi and Aldo Rusconi. Milan: Ulrico Hoepli, 1946. Pp. viii + 215. (Illustrated.) Lire 400.

This book covers more ground than the title suggests, since it represents a general survey of the advances of atomic physics from the advent of relativity and the quantum theory to the utilization of nuclear energy.

Chapter 1 includes a condensed account of the structure of matter, ions and electrons, Bohr's atomic model, isotopes, radioactivity, and Planck's quantum hypothesis. Chapter 2, bearing the title "Space, Time, and Causality," gives an elementary account of restricted relativity and of the failure of the principle of causality in quantum physics as expressed by Heisenberg's uncertainty relations. The authors take the occasion for setting forth certain views of their own on the structure of the geometrical continuum. In the reviewer's opinion, whatever the value of such theories may be, discussion of them should be reserved for papers of a technical character and is rather out of place in a book of this type. Chapter 3 is a discussion of the wave properties of material particles as expressed by Schrödinger's equation. Chapter 4 includes an account of radioactivity, artificial disintegration of nuclei, neutrons, and the conditions which determine nuclear stability. Chapter 5 discusses the fission of heavy elements and the utilization of nuclear energy.

The book does not require from the reader more than a general knowledge of elementary physics and mathematics, and the difficult task of popularizing such a vast amount of material is, for the most part, well done. Perhaps the account of the principles of restricted relativity and of quantum mechanics contains some obscurities that might have been avoided. Inaccuracies are few and unimportant.

This book will be particularly useful to readers of a scientific mind, such as chemists, engineers, biologists, etc., who, not being physicists, are not familiar with the more technical accounts of atomic physics and look for an elementary but accurate résumé of the subject.

Franco Rasetti

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Relaxation methods in theoretical physics. R. V. Southwell. Oxford, Engl.: Clarendon Press, 1946. Pp. vi + 248. (Illustrated.)

This volume, a continuation of the author's earlier monograph on *Relaxation methods in engineering science* (1940), constitutes an extremely important contribution to the literature of applied physics. It shows that almost any boundary-value problem in two dimensions for which one can write down the partial differential equations, and the solution of which one desires badly enough, can be solved by a sort of brute-force, cut-and-try numerical method of attack. It should go far toward dispelling the common idea that there is nothing that can be done about a two-dimensional problem for which an analytical solution has not or cannot be found, except perhaps to look for a physical analogue which is capable of experimental evaluation.

Southwell, in this volume, shows solutions of problems in torsion of solid and hollow cylindrical shafts, magnetic fields in regions containing iron, conformal transformation, capacity of cables, torsion of shafts of circular section but nonuniform diameter, torsion of tores, temperature distribution, shear stress trajectories, oil pressure and temperature distribution in bearings, flow of gas through convergent-divergent nozzles, plastic torsion, percolation, and shapes of free liquid jets.

The versatility of his methods is perhaps best illustrated by these last examples, in which the hydrodynamic equations are solved for free jets whose very shape is unknown at the start, and by H. W. Emmons' successful application (*N. A. C. A. Tech. Notes*, 1944, No. 932; 1946, No. 1003) of these methods to compressible-fluid-flow problems involving shock waves whose positions are initially unknown.

The relaxation procedure starts by replacing the two-dimensional continuum by a 'net' of points and the partial differential equation by a difference equation relating the function value at a given net point to its values at neighboring points. The finer the net, the closer is the approach of the solution of this difference problem on the net to that of the differential problem in the continuum. A trial-function value is estimated at each net point, and in terms of this trial function a 'residual' is computed, this being the amount by which the difference equation fails to be satisfied at each point. The residuals are then 'relaxed' to zero, or worked out to the boundary where they disappear, by successive and repeated changes in the function values at the various points, chosen at the discretion of the computer in such a way as eventually to make all the residuals vanish. The changes in the various residuals which occur with each change in a function value are made immediately on the net diagram.

Southwell's exposition of the actual computational procedure will be confused for many readers by his insistence on a mechanical analogy in which everything is expressed in terms of 'externally applied loads,' 'string tensions,' 'residual forces,' and the like. For such readers an excellent exposition of the procedure by Emmons (*Quart. appl. Math.*, 1944, **2,** 173) will be useful.

The very power of Southwell's method for handling problems *of whatever type* lies in the fact that *no* definite procedure is given for relaxing the residuals—one is only sure that if by hook or by crook he can get them relaxed, he has solved the problem. It is comfortable and convenient to have a definite procedure for 'relaxing the residuals' such as is given by the 'iteration' procedure, which has seen considerable development in recent years, but only for certain classes of linear, elliptic, partial differential equations. (See G. Shortly, R. Weller, P. Darby, and E. H. Gamble. *J. appl. Phys.*, 1947, **18,** 116, and earlier papers referred to therein. It is pointed out that the 'difference function,' the function 'relaxed' by the iteration procedure of these authors, is closely related to, although not identical with, Southwell's 'residual.') Southwell makes no comment on this procedure, but Emmons does, and it seems appropriate in a review of Southwell's book that some comparison be made for cases where the iteration procedure has been developed. Emmons gives a time comparison in which he says that a certain simple heat-conduction problem on a coarse, 19-point net took him 1.75 hours to solve by the relaxation procedure and the fantastic time of 11 hours "by the method of Shortley and Weller. . .with the use of a calculating machine" (*Trans. A.S.M.E.*, 1943, **65,** 607). The reviewer can only assert that the same problem took him exactly 26 minutes to solve by the last-named method, starting with the same plane trial function as Emmons and without the use of a calculating machine. It is his opinion that the 'iteration' procedure is certainly more convenient and probably more rapid than the 'relaxation' procedure in cases to which it has been applied.

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Elementary theory of gas turbines and jet propulsion.

J. G. Keenan. London: Oxford Univ. Press, 1946. Pp. viii+261. (Illustrated.)

The title of this book is aptly chosen. Volumes could be written on the theory of gas turbines and jet propulsion, but the author has produced a work for the benefit of the average scientific reader. The book will appeal to those who wish to become somewhat acquainted with the theory but who lack the mathematical and thermodynamic background necessary for a more rigorous treatment. With this clientele in mind, the author has avoided the concept of entropy and has based the theory entirely on pressure-volume relations.

By way of introduction the early history of the gas turbine is reviewed. Various components, such as nozzles, combustion chambers, diffusers, etc., are treated individually. The author has effectively arranged the material by first defining such technical terms as are pertinent to the discussion and then applying these concepts to the various types of turbines, compressors, and jets.

The centrifugal and axial-flow compressors are discussed with reference to velocity diagrams, work per stage, losses, efficiency, intercooling, and compressor characteristics. The impulse and reaction turbines are discussed very briefly under similar headings. A chapter is given to heat transfer, since that topic is so intimately associated with gas turbine and jet engine development.

Actual data on performance of this type of equipment are rather meager; however, graphical material is given to show the effect of pressure ratios, reheating, and compounding, and to show the thermodynamic limitations as well as the present stage of development. The various types of jet motors are pictured with their operating cycles shown on pressure-volume axes. The effect of such variables as altitude and air density on performance is given. The last chapter describes installations in which the various forms of turbines and jet motors have found application.

The book is well illustrated and is easily followed. It will fill a present-day need as envisioned by the author.

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La scissione nucleare dell'uranio: fenomenologia generale.

Emidio Prata. Milan: Ulrico Hoepli, 1946. Pp. 160. (Illustrated.) Lire 250.

After a few pages of introduction on nuclear reactions, the author describes the experiments that led to the discovery of fission (Chap. 1). Chapter 2 lists the identified fission products; Chapters 3 and 4, the mass distribution of fission fragments and their ranges in gases. Chapter 5 includes a detailed discussion of the stability of the nucleus against fission, the treatment following essentially the well-known papers of Bohr and Wheeler. Chapter 6 is a discussion of the instantaneous and delayed neutron emission in fission, from both theoretical and experimental standpoints. There follows a discussion of various cross sections for nuclear reactions (Chap. 7) and of the time within which fission occurs (Chap. 8). The conditions for a self-sustaining chain reaction and details on the chain-reacting pile as given in the Smyth report are given in Chapter 9. A complete bibliography of publications on fission from 1934 to 1943, including 325 titles, is given at the end of the volume.

The book constitutes a practically complete résumé of all the work on fission published in scientific periodicals up to 1943, plus a brief summary of additional information released by the Manhattan District after the war. The subject is competently treated, and apparently no essential data available at the time of publication are omitted. The book is evidently intended primarily for the physicist who is not a specialist in nuclear problems and who wishes to become acquainted with the essentials of the fission process. At the same time, it can be used profitably as a reference work by the nuclear physicist himself, the complete bibliography making it particularly valuable in this respect.

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The Shortage of Scientific and Technical Personnel:

What Industry Is Doing About It

Kenneth A. Meade, *Director of Technical Employment, General Motors Corporation, Detroit, Michigan*

IN PRESENTING THE VIEWPOINT OF INdustry with respect to the shortage of scientific and technical personnel I would first like to raise three questions: Is the shortage of such personnel, from a long-range standpoint, as acute as we have been led to believe? Is not the real shortage one of suitability of such personnel for technical employment rather than one of numbers available for employment? Finally, should not our attack on the problem be aimed at development of scientific and technical personnel who are well qualified to succeed in the field rather than at turning out a greater number of such people, many of whom will not remain long in technical work?

Today our economy is so integrated that anything which affects one element in turn affects most of the other phases. Our economy has become increasingly technical. National defense, public utilities, agriculture, and industry have become more and more dependent on scientists and engineers for their survival and their growth to meet the increased demands put on them.

I believe that the situation in the automotive industry, with which I am most familiar, is quite typical of that found in industry as a whole. In the early days of the industry the average plant was small. New products and improvements in products already in production were largely the result of work done by inventors. These men did not necessarily follow any organized program in producing new developments, but, as they tried new ideas and found that they worked, they put them into production. Sometimes the ideas were good, and the product sold, but, if the idea was poor, the product was apt to be a failure. As evidence, think back to names of some of the automobiles built in the first decade of this century which are only memories today. As a rule, however, these earlier products were rather primitive according to our present standards. The improvements and advancements that could be made were fundamental and obvious. Thus, inventors working without any particular plan could show progress.

At that time each unit of product was manufactured and produced on an individual basis. The parts were made by craftsmen using the standard tools of the machine shop and employing the skills of the toolmaker and machinist. These parts were fitted and assembled by skilled mechanics working on a complete unit until it was finished. Little thought was given to manufacturing processes and better production methods as we know them today. Consequently, the cost of these early automobiles was high, and the demand for them was small.

But, as automobiles became more popular and the demand increased, manufacturers had to find surer ways of improving the product and cheaper methods of producing it. Better-organized product development, mass-production methods, and the assembly line came into being. The individual parts were made as nearly alike as possible so that they could be used interchangeably in assembling the product and to facilitate its repair in service.

This fundamental shift in the way the business was carried on required changes in method and changes in the kind of personnel needed. The scientist and the engineer replaced the inventor; trained and experienced designers were needed; and toolmakers, diemakers, and other skilled craftsmen made the tools to build the product instead of the parts of the product itself. These parts could now be made by men with less skill, each trained to run a specialized machine designed to do a particular job. The finished parts were assembled into units and these units into the final product on assembly lines by men also trained to do their particular jobs. The industry became more specialized, plants grew larger, and those with responsibility for developing the product, planning the manufacturing methods, and managing the business were required to have more technical knowledge and ability.

So, today, in modern industry an increased number of men with scientific and technical backgrounds, obtained through either formal education or experience, is essential to its functioning. Refinements and advances that can be made in the product and processes are smaller and more difficult to attain than in the first years of the industry. As a result, scientists and engineers now have to plan more carefully and use the techniques of the laboratory to carry on organized programs of research and development on materials, manufacturing methods, and processes in order that the product of the future will be better and can be built at a lower cost. Sometimes these research programs result in complete new industries that further

An address delivered before the Symposium on the Shortage of Scientific Personnel, AAAS Boston Meeting, December 28, 1946.

increase the demand for scientific and technical personnel. New models of the product are designed, developed, and completely tested before they are put into production. Many of the men who supervise the building of the product have to have technical knowledge and skills to solve the day-to-day technical problems of production. In addition, the men who lay out the plants and plan the best routing of material and parts, as well as those who service the products in the field, need some technical training to do their jobs effectively.

There is an additional factor that, from our standpoint, contributes a great deal to the shortage of scientific and technical personnel. This is the problem raised by a sizable number of men who are trained in college for scientific and technical work and who, after a brief period of employment in the field, leave it to enter some totally unrelated type of occupation. These moves are usually made by individuals who believe they will find greater immediate returns for themselves in relation to happiness in the work, pay, or opportunities for advancement in the new activity. However, our experience has indicated that the reason may be a more fundamental one. Many of the men who make these changes are not fitted physically, mentally, or temperamentally for scientific or technical employment or, perhaps we should say, are better fitted in these respects for some other field of endeavor, and so they tend to gravitate away from technical work in their search for satisfactory employment. Whatever the reason, this group is to be found in every graduating class in every engineering college or technical school and reduces the number of men who are potential for the scientific and technical responsibilities in our future economy.

There are some contributions that industry can make in arriving at a solution to this problem of a shortage of scientific and technical personnel. However, a satisfactory and complete solution can be best obtained through the joint efforts of the educational institutions and employers of scientific and technical personnel toward achieving a better mutual understanding of the responsibilities involved.

In the first place, industry can do very little to increase the number of technical people immediately available for employment. This is largely the responsibility of the colleges and universities, and, since it takes considerable time to give science and engineering students their basic educational backgrounds, not much can be done to hasten the process. The immediate shortage is due to the fact that during the war years not as many young men were given an opportunity to prepare for scientific and technical work as in the years prior to the war.

However, while this immediate shortage in numbers of technical men available for employment exists, industry is doing certain things which help to relieve its effect. Veterans who went into military service immediately following the completion of a college or university course in science and engineering are being employed in positions for which we ordinarily recruit new graduates. Included in this group are many who were trained in military service educational courses, such as the Navy V-12 program. Men with scientific and technical backgrounds who were employed during the war years in temporary war jobs are being employed wherever possible. Maximum recognition is being given to the professional training of the experienced scientists and engineers already in our organizations in relation to their job assignments, in order that they may use their "know-how" most effectively. Quasi-technical employees, such as draftsmen, laboratory assistants, and experimental project mechanics, are found among veterans who obtained some specialized training in these fields while in the service as well as those who wish to go into industrial "on-the-job" training programs in these areas. All of these steps are aimed at the placement of technical and scientific employees in industrial positions where they can make their greatest individual contributions in relation to their particular backgrounds of education and experience. These efforts will help to spread the available supply of technical talent where it is most needed in industry until the present shortage is relieved in a few years by the graduation of larger classes now starting their science and engineering courses in our colleges and universities.

But from a long-range standpoint the problem is deeper than that of a shortage in the number of people educated for employment in these areas. There is also the problem of lack of ability to handle an industrial technical assignment among individuals who have passed the educational course requirements for this kind of employment but who do not possess the other qualifications needed. As I see it, the solution of this problem involves two things: better selection of those to be educated for industrial employment, and development of an attitude in the graduate that will help him to find his place in the industrial scheme more quickly.

Every field of work has rather definite requirements of knowledge and skills as well as of mental and physical abilities; every job requires some capacity to handle human relations problems; and every job requires specific interests on the part of the one who does it and should satisfy certain desires and ambitions on his part. Since the professional technical and scientific employees of industry are a part of management, their jobs have the added requirement that, to qualify to fill them, an individual must have the background on which to develop a management viewpoint and method of attack on problems.

So, to find the right person for a job we must find the applicant who has all the attributes required by that job. Some may argue that anyone can do any job to which he puts his mind, and this may be true in the exceptional case. However, most of us are better qualified for one particular field of work than for some other, and it is in this field that we as individuals can make our greatest contributions to our employers, society, and ourselves.

A college degree in engineering, physics, or chemistry or good grades in specific courses are not enough unless the individual possesses the other abilities—the mental discipline, the capacity for dealing with people, and the interests the job requires. Only when we place on a job the individual who has all the attributes required in that job will we have an employee who is happily placed, will do his most effective work, and hence make the greatest contribution to the organization employing him. By making that contribution he will benefit himself. Therefore, the student who is interested in science or engineering should be assisted in analyzing himself and the fields of work for which he wishes to qualify. By the time he is graduated he should know what he has in the way of abilities, human relations attributes, interests, and desires that have been developed so far and will thus be in a better position to determine in what field he should seek employment—teaching, research, production, technical sales, etc.

What is the responsibility of our educational institutions in this connection? I believe that most of us will agree that for the majority of industrial jobs in the technical field an employee needs a good educational grounding in fundamentals rather than a highly specialiized background. There are, of course, the exceptions of some highly specialized research and design jobs. He needs a good working knowledge of the physical sciences, mathematics, design, the laws of economics, and the psychology of human relations. He must be able to express himself clearly and forcefully either orally or in writing. An individual in whom the college or university has instilled this fundamental background should not be limited in his outlook or in the type of industrial job in which he can successfully develop.

But these are only his tools. He must learn how to use these tools. He must learn how to think clearly. Any curriculum in science or engineering should so prepare the graduate that he can apply the same scientific method of analysis to the solution of such problems as those of production, industrial relations, and business economics as he does when working a problem of research, design, or development. Industry is sometimes criticized by educators for not recognizing the professional status of all the graduate engineers in its employ because some of these are found several years after graduation in technicians' jobs that could just as well be handled by people with less training. The graduate engineer or scientist who, after he gains experience and knowledge, does not have the ability to solve major problems in the industrial field is no more a professional man than the doctor who graduates in medicine but cannot pass the state medical board examinations to practice.

Technical colleges and universities have the added responsibility of using the techniques developed by the psychologist and others who have specialized in the study of the behavior of people for better selection of those students who have the greatest aptitude for success in the fields of science and engineering. They have the responsibility of counseling their students and assisting them in analyzing themselves in preparation for their selection of the field of employment in which they have the best chance for success.

Each industry has the responsibility of furnishing the technical schools with pertinent information in regard to its policies, management philosophy, products, geographical scope, financial standing, and the educational backgrounds and attitudes expected in the graduates it employs. Industry is responsible for carefully analyzing its technical and scientific jobs in regard to the abilities, skills, human relations attributes, and interests required in each one and in regard to the personal desires each one will satisfy and for furnishing this information to the schools for student guidance purposes. Industry can inform the technical graduate about its training programs, benefit plans, and the opportunities it offers to a man with a technical background.

Industry also has the responsibility of training those graduates it employs and assisting them in bridging the gap between supervised development in the college classroom and self-development on an industrial job. Some such training must be furnished, since the colleges and universities cannot be expected to train individuals for specific industries. Industry, therefore, is responsible for furnishing the new employee with information on the products, processes, operating principles, and procedures of its organization. Through conferences with members of management he should have an opportunity to learn their methods of operation, philosophy, and point of view in preparation for the responsibilities that may lie ahead. In addition, during this preparatory period of employment he should be given working experience in the various phases of work related to the job and department for which he has been employed. Such a program, whether formal or informal, gives the employer a better opportunity to observe the performance of the individual in order to assist him in finding the specific field of work for which he is best qualified to make the greatest contribution in the years to come. While emphasis is put on intensive training during the first few years of employment and whenever the employee is transferred or promoted to a new job or another unit of the organization, it does not stop there. It takes a long time to learn the art of management, so his training, no matter how informal, will continue as long as he stays with the organization and grows in ability to assume greater responsibility. For this training to be effective, the graduate cannot start with an antimanagement point of view for, if he does, he sabotages the organization from inside.

General Motors feels that proper training of all employees is a very necessary part of its personnel program.

Each division has set up training programs to fit its individual needs. The importance of training is indicated by the fact that a central training agency—General Motors Institute—has been in operation at Flint, Michigan, for more than 25 years. The staff of the Institute assists the divisions and operating units in analyzing their training needs and in the design, development, and administration of programs to meet those needs. Management training for shop foremen and other first-line supervisors has been given considerable emphasis and has proved invaluable in developing an efficient organization. The Institute also operates a cooperative college course in Industrial and Mechanical Engineering which each year furnishes our various plants with more than 150 graduates, each trained for specific responsibilities in the technical and manufacturing phases of the business.

Training helps the employee to orient himself to the organization and to learn to apply whatever fundamental educational background he has to the job at hand and to the ones that lie ahead. It is one of the best ways of assisting the employee in getting the most out of his job.

With the cooperation of industry the colleges and universities should be able to do a better job of student selection and counseling, so that those who are graduated and enter the technical and scientific fields will have a better chance of success and will be more apt to make a career of these fields.

In addition, there is the problem of developing in the technical or scientific student an attitude needed for industrial employment. After all, he is not recruited as a factory laborer or into a routine job in which he will spend the rest of his life. He is employed because management believes he has possibilities for development into a management position himself. A willingness to work on any phase of the job to be done, a willingness to accept criticism and suggestion, a willingness to become a part of management and to accept the responsibilities of management are all a part of this attitude.

In order to give a better idea of what we mean by attitude as it relates to the college graduate going into industry I would like to quote from a talk given by William E. Wickenden, president of the Case School of Applied Science, at the General Motors Institute Commencement in August 1946:

> . . . But there is another thing, which seems far more important, which you can do uniquely perhaps, and that is to make the process of education bridge over the gap between school and practice in which so many men seem to lose the momentum of intellectual mastery and professional growth. The most important thing anyone can learn in school is not some collection of items of knowledge or tricks of skill, but the art of carrying on his own education without a teacher's supervision and the conveyor belt of a curriculum and academic schedule. That art, I regret to say, we too often fail to develop or, if we do, it will too often fall a casualty in the first few months out of college. . . .

Finally, it is most important that the graduate have a firm belief and complete confidence in the policies and management methods used in the organization he joins and that he be motivated not only by what he hopes to gain personally from the company but also by a desire to make a contribution to it. It is fundamental that, if any student leaves college with the opinion that the present system of industrial management is subject to serious question, he will have great difficulty in fitting into and becoming an effective part of the management group. If this is not his objective, he should not look to industry for his opportunities.

Unfortunately, not all members of college or university faculties have had an opportunity to gain industrial experience and, as a consequence, not all of them are prepared to give their students a very realistic picture of what to expect when they take industrial jobs. Many men in technical or management positions in industry have not had an opportunity to obtain a firsthand knowledge of the problems of the engineering school. Too often their opinions of educational courses or of a particular educational institution are based on hearsay or an unfortunate experience with a few poorly prepared college graduates. Some of them feel that students are often taught courses dealing with the way the instructor or textbook writer would like to have industry do a job rather than courses explaining how it is actually done. We cannot expect members of the college faculties to give their students anything of management's viewpoints unless they have been given an opportunity themselves to study at firsthand and appraise these viewpoints as they are applied in different companies. I believe that conferences between educators and men in industry who employ technical graduates, where information is exchanged and where college courses and industrial training programs are constructively criticized, will do a great deal toward the solution of these problems. Faculty members would then be better equipped to develop in their students a broader and more realistic viewpoint and prepare them to make the shift from college into the industrial field more readily. Industrial management will be better informed as to the backgrounds of education and attitudes of the graduates they employ and more sympathetic toward their problems of orientation to industry.

During the last two years we have held short summer conferences of our management with educators in the fields of industrial relations and personnel. The purpose of these is to give a group of college and university men who are teaching courses in labor relations and related subjects an opportunity to observe at firsthand our methods of handling problems in these areas. At each conference the educators first met with members of our personnel staff. Next each educator was sent to one of the company's plants and given an opportunity to observe for several days any phases of the personnel program and to discuss his observations with members of plant management. Finally, the group returned to Detroit and, after spending a day exchanging ideas obtained from their plant visits, presented their comments and suggestions to interested members of our Corporation management, the personnel staff, and personnel representatives from our divisions and plants.

In order to give a greater number of educators an opportunity to gain this kind of experience so that they will be in a better position to present their students with a more realistic picture of what they can expect when they accept industrial employment, this experiment should not be confined to one company or one field of education. We should consider its application or the application of other methods to the fields of science, engineering, finance, and distribution, among others.

I firmly believe that by pooling the experience and "know-how" of employers with that of faculty members and administration of our colleges and universities we will find better ways of producing technical and scientific graduates who are better qualified to do their jobs and more interested in making these fields a career wherever they choose to accept employment. This cooperative attack from a long-range point of view will, it seems to me, help to insure more effective use of technical and scientific graduates in industry. This may be more important than producing a larger number of graduates, many of whom leave this field of work after they are trained for it. Let us put greater emphasis on producing quality rather than on just increasing the number of graduates in the technical and scientific fields.

The Scope of Science

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WHEN, SOME MONTHS AGO, I FIRST read the paragraphs in British publications which provide the text and motivation for this article, I was so amazed and dismayed by what seem to me partially erroneous and wholly misleading statements that I felt impelled to make immediate reply. But on further reflection, being of a noncontroversial disposition and much averse to giving my time to expression of disagreement, I inhibited the impulse. Recently there have been developments which brought the matter to my mind again, and this time with such sense of duty and opportunity that I am now offering critical rejoinder and alternative view. Unwillingly I write in the first person, since I may not assume that the British writers speak for their scientific colleagues or the British people, and since I have no mandate to represent my scientific colleagues and my fellow citizens of the United States of America.

The first half of my text appears in the following paragraph from an editorial entitled "The method and scope of science," published in "a quarterly review designed to record the progress of the sciences in the service of mankind," which is "made and printed in Great Britain." The journal is called *Endeavour*.

> It is, however, in the realm of qualities not susceptible of measurement of any kind that the scientific method—as far as it has yet developed—ought frankly to be recognized as *inapplicable*. An obvious example can be taken from the field of art. The scientific method can give a great deal of information on the chemical nature of pigments, on the wavelength of the light they reflect, and on similar factors, but *it is wholly unable to predict* whether a picture will have an aesthetic appeal to those who see it. *Nor can the scientific method be of help* in those problems relating to drama, literature, and the like, which involve *qualities that cannot be measured* and knowledge which is not communicable. In the wide field of human affairs *the scientific method cannot be applied*, even in the form of statistical analysis, to problems in which events are influenced by the philosophical values of goodness, truth, and beauty, and emotions such as patriotism, fear, or political conviction (*Endeavour*, 1946, 5, 126). [Italics by R. M. Y.]

In this emphatic statement of opinion I should wish, on the basis of my knowledge of fact, to convert all the negatives—the impossibles and improbables—into positives. Thus "inapplicable" becomes "applicable"; "it is wholly unable to predict" becomes "it is partially able to predict"; "nor can the scientific method be of help" becomes "the scientific method can be of help"; "qualities that cannot be measured" becomes "there are no qualities of natural phenomena which cannot be measured, although at present there are many which are not being measured or are measured very crudely and inaccurately"; and "the scientific method cannot be applied" becomes simply "the scientific method can be applied to all natural phenomena."

Actually, what the writer of the editorial deems impossible I have observed being done in what chances to be my country, culture, and sphere of creative scholarship, on all sides and increasingly throughout my life. For nearly 50 years most of my time and intellectual resources have been devoted to efforts, sometimes recognized as successful, to do just what is termed impossible or improbable. Under the circumstances, it would require much more than an exhibit of authoritarian belief or emphatic assertion of individual opinion to convince me—and I am sure that in this I may speak for hundreds of my scientific colleagues and associates—that what I have observed by way of research endeavor and progress is illusory, and that we who are working as biologists and social scientists are not achieving dependable and serviceable results in our varied studies of behavior, experience, social relations, and institutions. If the natural phenomena designated by such terms are not amenable to systematic study by procedures which are in principle the same as those employed in the physical sciences, hosts of us who now are classified as scientists actually are self-deceived workers who, unlike our physical science colleagues, are denied access to the truth concerning the natural phenomena which particularly interest us.

My proof? As exhibit in support of the positive statements which I have made, I offer simply the literature of technical report and general discussion classified under functional biology, psychology and psychobiology, anthropology, sociology, and other so-called social science categories. I have in mind, as especially pertinent, the literature of the 20th Century. It seems idle to cite titles from our numerous journals, monograph series, and books. With regret I admit that I am a bit suspicious that the negatives of the editorial, and the writer's obvious lack of faith in the applicability of scientific procedures to psychological and social phenomena, indicate ignorance of this vast array of recent discovery and of technical applications in various branches of human engineering. Perhaps there is also a tendency to look backward in the history of science instead of examining current activities and, with that as vantage ground, trying to look forward optimistically and prophetically. Assuredly, history, and especially the history of science and of man, is invaluable for our guidance, but its making is far more exciting and fate determining than is mere recording or subsequent rewriting. One dislikes to admit that he appears to be living in another world of fact and striving than that of his opponent, and I earnestly hope that the writer of this editorial and I shortly may discover that we both are scientists in spirit and achievement and may come to agree that assertion or prediction of the impossible is an unprofitable exercise in our callings which not infrequently makes one appear foolish to one's successors. I cannot even be so charitable as to wish that I may come to accept the point of view or faith of this writer, for I am reasonably sure that he is mistaken, and I hope to convince him, and all who sympathize with him, of that fact!

As to the second half of my text, less words of comment are required since it is a specific exhibit which might have been used in *Endeavour* in support of the general negations. I borrow it from an important report of effort to further human welfare by application of dependable knowledge. *The Peckham experiment*, by Innes H. Pearse and Lucy H. Crocker, physician and social worker, respectively, commands my admiration and, apart from such exceptional disagreement as I herein note, my enthusiastic approval. It deserves to be widely read, and it should become influential. My interest in the book led me months ago to urge that it be made available in an American edition. Perhaps if I knew the authors as well as I now know their experimental outlook and services, I should not have the heart to criticize them! The paragraph to which I wish to take exception is entitled "The Place of Psychology in the Peckham Experiment." It reads thus:

> One last word. The Centre has often been accused of neglecting Psychology. In our opinion, however, there is as yet no psychology; only a knowledge of psycho-*pathology*. Indeed, how can there be a scientific study of psychology until an experimental field for the *study of the healthy* has been established? At present, knowledge of the physiology of the psychological mechanism lags far behind its pathology which fills libraries, for all knowledge so far available on this subject is derived from the disordered, and its theories and technique are devoted to remedy. Remedy is important for the sick, but the sick are not the primary concern of the Centre. Once however a medium is found in which we can watch the action-pattern of function in the family unit, we are presented with an experimental field in which we can begin to look for a psychology based upon health rather than pathology (*The Peckham experiment: a study of the living structure of society*. New Haven: Yale Univ. Press, 1945. Pp. 272-273).

The assurance and finality of statement in this case are devastating. As a psychobiologist whose affiliations and services for a half-century have been primarily medical, and as one who recognizes the existence and value of psychology as extension of physiology to include the whole of human behavior and experience, I am deeply sympathetic because of the disadvantages under which the authors of this report labored. By their own statement, it is in a land and culture in which, apart from psychopathology, there is no science of psychology. But in this matter, what of the world situation? And what, I apprehensively ask myself, will the thousands of American psychologists, my colleagues and co-workers, think and say when they read: "In our opinion, however, there is as yet no psychology." Will they respect the efforts of our British co-workers for human welfare, or will they instead say that such ignorance, narrowness of view, and provincialism are inexcusable? Science generally is considered international, and it certainly should be reasonably independent of local advantages and disadvantages.

In this case also I offer as eloquent exhibit to disprove the authors' negatives the world's literature of psychological science and especially that of America during the current century. Reports of research progress are to be found in a score of technical journals and other serials. Our handbooks, manuals, encyclopedias of psychological fact, method, and generalization are many. In America psychopathology is recognized as special development from, and an important part of, the science of normal behavior-experience. If the various divisions of biology, functional and structural, are entitled to acceptance as natural sciences of measurement and prediction, then, from the facts provided by these exhibits, we must grant that psychology actually exists as science. Moreover, whether or not we chance to be medically trained or interested especially in psychopathology, we psychologists and psychobiologists are working in the spirit, with the objectives, and, in principle, with the methodologies of the other physical and biological natural sciences.

Obviously, my disagreement with the authors of *The Peckham experiment* is absolute. Nevertheless, as scientists we all are committed to strive for progress, and most of us recognize that what today appears impossible may be achieved tomorrow. I should like to suggest, if it be not presumptuous, that either the Crown or the Prime Minister of Great Britain appoint a commission of experts to visit the United States of America expressly to inquire into the existence and status of the "impossible" sciences of human behavior-experience, social organization, and institutions, and to report authoritatively and informatively to the people of Great Britain. Belief and action should not depend upon the assertions of the editors of *Endeavour*, of the authors of *The Peckham experiment*, or of an American scientist who refuses to admit that it is impossible for any one person to be physicist, biologist, sociologist, all in one, and to seek always to advance knowledge and human welfare as *scientist*, sometimes as *specialist*.

On the Multiple Factor Theory of Respiratory Control as Outlined by Gray

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A RECENT ARTICLE ON A MULTIPLE factor theory of control of respiratory ventilation (*4*) carries certain wide implications for which the author did not present the necessary substantiating data. Furthermore, many of the statements seem highly questionable, if not erroneous; e.g. a categorical statement that all preceding theories of control have "consistently met with failure" is presented without evidence.

Gray states that Gesell's theory "avoided the objections to the arterial H-ion theory" and that "the improvement, however, is more apparent than real, for the H-ion concentration of the cells of the respiratory center is still beyond measurement." If this statement means that Gesell's theory is difficult to handle quantitatively, we must agree. Otherwise, the meaning is not clear.

There is a considerable body of evidence that respiratory center acidity and chemoceptor acidity run parallel to respiratory minute volume. Cerebrospinal fluid acidity (*2*) offers a first approximation of central nervous system acidity. These approximations have been abundantly supported by observations on venous blood acidity. Present information on central nervous system chemistry and metabolism permits related deductions concerning the acidity of the center (*7*). Whatever method is employed to appraise intracellular acidity of the respiratory center and chemoceptors, the premise that intracellular acidity plays an important role in the control of respiratory ventilation is supported (*2*).

Gray seems to have accepted the views of Gesell on this major issue of intracellular acidity, for he writes as follows:

> The second step in the application of the multiple factor principle is to decide at what point the concentrations of the three chemical agents are to be measured. Although ideally their concentrations should be measured in the respiratory center and the peripheral chemoreceptors where they exert their effects, this is not feasible.

This is a point which cannot be passed over lightly, for if one fact is established with reasonable certainty, it is the lack of correspondence between the concentration of H-ions and of CO_2 in the arterial blood and the volume of respiratory ventilation. Of all the points of concentration, arterial blood is the least informative. Yet Gray states that "the most feasible approach is to correlate respiratory ventilation with the arterial concentration of the three chemical agents, bearing in mind the possibility that difficulties may arise in transitory unsteady states and in conditions of seriously altered blood flow."

It is a well-known fact that venous blood is usually more acid than arterial blood and that the increase in

H-ion concentration occurring as it passes through the tissue is due to the addition of acid metabolites to the blood by the tissues. Gesell and his co-workers have clearly shown that hemorrhage increases the difference in H-ion concentration of venous and arterial blood. Despite a decrease of H-ion concentration of arterial blood of pH 0.1 or more, due to augmented ventilation of the blood in the lungs, both the venous blood and the cerebrospinal fluid turn more acid than normal as a result of hemorrhage (*6*). Such exaggeration of differences in H-ion concentration of arterial and venous blood is not so transitory as Gray seems to imply and throws considerable light on the mechanisms of respiratory control. Yet Gray is of the opinion that "venous blood levels are unsuitable because of the extreme variability in the composition of venous blood. Neither mixed venous blood nor blood from any accessible vein reliably reflects conditions both within the respiratory center and in outlying chemoreceptors. The only remaining possibility is arterial blood." It is one matter to use the H-ion concentration of the arterial blood to meet the convenience of the investigator. It is another matter, as Gray himself has pointed out, to select the site of concentration which throws most light on the mechanisms involved in the control of respiratory ventilation. If one uses the H-ion concentration of the arterial blood because it reflects the acidity of the respiratory center, as Gray in one place implies, it is somewhat illogical at another place in the line of reasoning to consider the H-ion concentrations of the arterial blood as the stimulating agent. Gray's dilemma increases on realization that the volume of pulmonary ventilation varies inversely as the H-ion concentration of the arterial blood in a number of important types of hyperpnea, and in some of these the carbon-dioxide pressure is low and the oxygen pressure high.

GRAY'S CHEMICAL VENTILATION EQUATION

The chemical ventilation equation as given by Gray (*4*) is:

$$VR = 0.22H + 0.263pCO_2 - 18.0 + \frac{105}{10^{0.038pO_2}}.$$

Such an equation is a device to predict the magnitude of the ventilation when H, pCO_2, and pO_2 are known. But we doubt very much, unless independent substantiating evidence is presented, that the equation can be used to establish causal relationships or provide information on the mechanisms by which H, pCO_2, and pO_2 are related. While the algebraic device is simple to handle from the standpoint of the mechanical manipulations of the data, it is not necessarily better than other devices, and other devices should be avoided only after proof is presented that they are less reliable than the algebraic device. A rigid mathematical analysis will also give a product which can be used to predict respiratory volume. The problem is which prediction will give the smallest relative or absolute error. The equation to be favored is the one giving the most accurate prediction. Among the equations deserving investigation are (1) and (2), formulated by Krueger.

$$(1) \qquad y = ax^by^cz^d \text{ or } \text{Log } y = \text{Log } a + b \text{ Log } x + c \text{ Log } y + d \text{ Log } z$$

$$(2) \qquad y = ab^xc^yd^z \text{ or } \text{Log } y = \text{Log } a + x \text{ Log } b + y \text{ Log } c + z \text{ Log } d$$

$$\text{or Log } y = A + Bx + Cy + Dz.$$

None of the equations, including Gray's, has any value unless the probable or standard error of the prediction is also known. One can predict the magnitude of ventilation even without knowing what is meant by volume of respiration; but here the probable error of the guess is exceedingly great. A prediction is valueless unless one can associate with it a standard error and thus provide some concept of the validity of the prediction. Gray has neglected to include the standard error with his equation. Further, Gray's equation would be of value only where it can validly be used. Gray defines the realm of validity as any condition where H, pCO_2, and pO_2 of the arterial blood, operating normally, are controlling respiration. But what are the criteria that only these three factors and not others, such as muscle and other reflexes, pain, body temperature, or metabolism, are influencing respiration? When do these factors operate *normally?* The validity of a predicting equation also depends upon the source and quantity of data from which it is derived, and Gray has not published this information.

As a reason for avoiding a product of H, pCO_2, and pO_2 for the prediction of the magnitude of ventilation, Gray has said that taking the product of partial effects implies synergistic action, and that such a procedure should be avoided until actual evidence of synergism is encountered. If this were true, his own equation should also be avoided, because that equation implies synergism. Synergism usually is defined as a working in the same direction. In his equation the H, pCO_2, and pO_2 components are always positive and hence always *arithmetically* as well as *algebraically additive.* Since the three components always act in the same direction, they are, by definition, synergistic. If one is to consider Gray's equation as a functional mathematical equation rather than a prediction equation, one wonders how the constant -18.0 is to be interpreted. The constant can be separated into three components, each to be associated with the H, CO_2, or O_2 component, and thus provide the possibility for negative partial effects related to the H, CO_2, and O_2 components. Yet one must keep in mind that (1) the arterial hydrogen ions and carbon dioxide are presumed to stimulate in proportion to their concentrations; (2) the oxygen always gives a positive component which is less, the higher the oxygen concentration; and (3) the effects of the H, pCO_2, and pO_2 components are always positive, no matter what negative constant is associated with them. This difficulty could be eliminated by establishing arbitrary zero lines for H, CO_2, and pO_2 and using a more complex function of these components; but Gray has neglected to do this. Hence, if one accepts his formula as a functional mathematical equation, one must conclude that the effects of H, O_2, and CO_2 are arithmetically additive (always positive) and hence synergistic, that these factors operate on a center whose nonstimulated condition represents a value of −18.0, and that the sum of the O_2, CO_2, and H components must reach 18.0 before ventilation occurs. A more logical attitude is to treat Gray's equation as a pure prediction equation. If we know something of the H-ion concentration, the arterial O_2, and the arterial CO_2, we can make a prediction regarding the magnitude of the ventilation.

Beyond presenting his prediction equation, Gray's only suggestion, offered without proof, is that certain factors may act independently. Gray holds that "if it were true that only one of the two agents [CO_2 or H-ion concentration] is the true stimulus, the procedure used to establish the equation [4] would have betrayed the fact by emerging with a coefficient of zero for the inactive agent." In order to reduce this argument to an absurdity, an equation will now be derived from Gray's equation where the coefficient of CO_2 is zero; then, if we were willing to follow the logic of Gray, we could conclude that it was not the CO_2 and H-ions of the arterial blood, but rather the bicarbonate ions and the H-ions which were the true respiratory stimuli. From the law of chemical equilibrium,

$$(3)\quad [H^+] \times [HCO_3^-] = K_1 \times [H_2CO_3] = K_2 \times pCO_2 \quad (5).$$

Hence,

$$(4)\quad pCO_2 = [H^+] \times [HCO_3^-]\, K_3,$$

and substitution in Gray's equation yields Equation 5.

$$(5)\qquad VR = 0.22H + 0.263 \times K_3 \times [H^+] \times [HCO_3^-] - 18.0 + \frac{105}{10^{0.038 pO_2}}.$$

In Equation 5 the coefficient of CO_2 is zero. Because we do not attach any functional significance to either Gray's equation or Equation 5, we continue to believe that the blood carbon dioxide *influences* respiration.

Gray uses his equation to predict the relationships in passive muscular exercise. He assumes that the passive nature of the exercise prevents any change in metabolic rate. The metabolism during passive exercise is readily amenable to evaluation and should be evaluated experimentally before assuming that metabolism will not be changed. Since the experiments of Cohnheim on *Sipunculus* and of Cohnheim and Von Uexküll on the leech showed that the energy consumption is greater in these animals when loaded than when unloaded (*1*, p. 538), it is possible that the changes in tension and length may produce an increase in metabolism during passive exercise. Hence, one cannot as yet take at face value the calculation which associates no change in metabolism with a decrease from 40 to 29 mm. Hg in the blood carbon-dioxide pressure, a change in pH from 7.41 to 7.52, and an increase of 40 per cent in ventilation during passive exercise.

COMMENTS ON NIELSEN'S THEORY

Nielsen (*9*) views CO_2 as the unique stimulus for respiration and assumes that the irritability of the respiratory center to this stimulus is variable. CO_2 produces a greater increase in respiration per unit change in the pH of the arterial blood than is produced by other acids. Gray categorically claims that a unique potency of CO_2 is denied by the fact that both acid and CO_2 increase respiration. He seems to overlook the fact that injection of acid causes an increase in CO_2 and that CO_2 could be the effective factor in producing an increase in respiration. We would like to comment further that there is some similarity between Nielsen's theory, invoking the unique stimulus of CO_2 acting upon a center whose irritability varies, and that of Gesell, which relates the changes in respiration to tissue acidity and to the acetylcholine concentration at certain key points. If the irritability in Nielsen's theory were defined in terms of bicarbonate and acetylcholine content, the two theories would be very closely related. In that acetylcholine and acidity are more clearly defined entities than irritability, it is easier to think in terms of Gesell's theory than of Nielsen's. The latter theory is a reflection of early similar statements by Loewi (*8*) and others.

CLASSIFICATION OF THEORIES OF RESPIRATORY CONTROL

Careful over-all consideration of the adjustment of breathing leads to the inescapable realization that a very large number of factors—many more than are usually considered—must participate in the control of respiratory ventilation. Gesell (*2*) and Gesell and Hansen (*3*) have emphasized this point in their papers. If it is true, as these authors have suggested, that the electrogenic properties of acetylcholine may provide the activating forces of the respiratory center, the heterogeneous factors contributing to the control of breathing become resolvable into a final common factor, namely, concentration of free acetylcholine in the respiratory center. Synaptic bombardment of the respiratory center by impulses originating in chemoceptor endings, in pain endings, in proprioceptive endings of the lungs, of respiratory muscles and locomotor muscles, and impulses originating in the higher centers should lead to liberation of acetylcholine in the center. Increased acidity of the center resulting from any of many possible causes should, by its anticholinesterase activity, potentiate the effects of prevailing bombardment of the center. Theoretically, an increase of H-ion concentration and of CO_2 concentration and a decrease of O_2 concentration of the arterial blood should increase the acidity of the tissue. Thus, these three factors, which Gray has emphasized, are theoretically resolvable into the single factor, tissue cH. The view that both increased bombardment of the center and increased intracellular cH lead to increased concentration of acetylcholine offers an extremely simple theory for explaining respiratory ventilation. Because a host of heterogeneous factors must be theoretically resolvable into a final common factor such as neurocellular electrotonic currents, however, is no reason for identifying Gesell's theory as a single factor theory. If there be need of classifying theories of respiratory control into single and multiple factor theories, Gesell's theory should be included with the latter. A quantitative elaboration of all the factors to which Gesell has called attention is a more difficult problem. Although much quantitative data concerning the regulation of respiration are available, any inclusive formulation which would account for the many factors and their interactions becomes extremely cumbersome. On the other hand, necessary simplification renders any such formulation hypothetical.

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Reply to Krueger's Criticism of the Multiple Factor Theory

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A THUMBNAIL SKETCH OF RESPIRATORY theories will be of assistance to the reader whose only recent information on the subject consists of Krueger's article. Early theories which postulated a *single arterial stimulus* for respiration have long been realized to be incompatible with experimental observation. Later theories, which have added a second postulate, that a number of factors influence the *sensitivity* of the respiratory center to the unique arterial stimulus, are also at variance with experimental observation. A third type of theory, such as Gesell's *original* theory, which postulated that ventilation is controlled by a single *immeasurable* stimulus, namely, the intracellular pH of the respiratory center, is impossible to quantitate. In order to avoid these difficulties, the multiple factor theory postulates that a *number of stimuli* exert individual effects on ventilation; that the levels or concentrations of these stimuli are frequently influenced by one another; and that, as a result, the actual ventilation represents the algebraic sum of the partial effects of the separate stimuli. The logical implications of these postulates have been worked out in detail and given quantitative mathematical expression; they have been applied to very extensive and well-known experimental data and found to give excellent agreement and to provide a greatly enhanced understanding of the control of respiration. All these details have been presented in a series of seven wartime reports (*1–5*), totaling some 220 pages, released from the AAF School of Aviation Medicine. The *Science* article (*6*) which Krueger criticizes constituted a brief summary of the principles and general nature of the theory.

The multiple factor theory, like any other theory in science, can be legitimately criticized on the grounds that it fails to correspond to experimental observation, or that it is logically inconsistent with itself, or that it is not verifiable. Few of Krueger's criticisms fall into any of these categories, as may be seen from the following criticisms and answers:

(1) Krueger's opening sentence claims that necessary substantiating data were not presented. This accusation is made a number of times. The facts are that extensive substantiating data were presented in the wartime reports (*1–3*) (available on request) given as references in the *Science* article, but which Krueger has ignored. More

detailed evidence of the failure of preceding theories is also included in these reports.

(2) In his second paragraph Krueger states that the only interpretation he can make of my criticism of Gesell's (original) theory is that it is difficult to handle quantitatively. This interpretation is correct. Is it an error to consider unsuccessful a theory which is not amenable to quantitative expression, but which, nevertheless, treats of quantitative events? Krueger implies that my criticism of Gesell's *original* theory was leveled at Gesell's *modern* theory. In fact, the main theme of Krueger's paper is the defense of Gesell's modern views against my supposed attack. This defensive effort would have been more appropriate had there been any actual attack. I can do no better than quote my original words (*6*):

> This modified theory [Gesell's] is no longer primarily a theory of the over-all regulation of respiration [in contrast to the multiple factor theory]; rather, it is primarily a theory concerning the intracellular mechanisms by means of which certain agents, involved in the control of respiration, bring about stimulation or activation of receptor and effector cells. The two types of theory, however, are neither mutually exclusive nor competitive, but complementary.... It is important to distinguish clearly between the over-all regulation of respiration for homeostatic purposes and the intimate cellular mechanisms involved.... Like thermodynamics, it [the multiple factor theory] is concerned with the beginnings and ends of processes and not with intervening steps, however important the latter may be from other standpoints.

(3) Krueger registers numerous objections to the use of arterial blood levels of the chemical stimuli.

(a) One objection is based on the claim that arterial levels are least informative because it has been established that they do not correlate with ventilation. What had already been established was that no *single* arterial agent correlates with ventilation; what I have established on the basis of experimental data is that *multiple correlation* between ventilation and the *several* arterial agents is quite good.

(b) Another objection is based on the allegation that arterial levels were chosen "to meet the convenience of the investigator" instead of to "throw more light on the mechanisms involved in the control of respiration." Arterial levels were admittedly selected because they are more feasible to measure; my preference for accomplishing the feasible rather than speculating on the infeasible seems not to be shared by Krueger. Having selected a feasible procedure, it thereby became possible to discover that it threw more light on the control of respiration. The justification for this selection consists of the fact that it led to the discovery of a multiple correlation between arterial levels and ventilation.

(c) Krueger accuses me of inconsistency in considering the arterial H-ion to *reflect* the acidity in the respiratory center in one place and in another to *be* the respiratory stimulus itself. The fact is that I did and do consider the arterial pH in many important conditions to be a measurable index of the effective pH, whatever the value of the latter may be and regardless of its site of action.

(d) Krueger implies that I have not considered situations in which arterial and cellular pH's may be dissociated. The truth is that I have considered some of these conditions in considerable detail (*2, 4*).

(4) Krueger also devotes a number of pages to criticism of the chemical ventilation equation.

(a) Doubts are expressed that it "can be used to establish causal relationships." The fact is that no equation ever established causal relationships, and this one was not intended to do so. If one must think in anthropomorphic terms, it might be pointed out that the chemical ventilation equation describes the "causal" effect of arterial pCO_2 on ventilation, and the formal ventilation equation describes the "causal" effect of ventilation on the arterial pCO_2, thus for the first time explicitly clarifying certain confusing "causal" relationships in respiration.

(b) Doubts are also expressed that the equation can "provide information on the mechanisms by which H, pCO_2, and pO_2 are related." These doubts are well founded; the equation does not and was not intended to do this. A group of three other equations were provided for this purpose.

(c) Krueger objects to the chemical ventilation equation because other "equations deserving investigation" were not explored. As a matter of fact, the chemical ventilation equation represents the only one among a number explored which was found to describe the experimental data. It must be confessed, however, that no attempts were made to fit exponential or logarithmic equations to linear data!

(d) Krueger also objects to the algebraic summation device on the grounds that simple arithmetic summation is all that is required. The thread of the argument at this point becomes incoherent. He says that the equation "provides the possibility for negative partial effects" and, further on, that from the equation "one must conclude that the effects of H, O_2, and CO_2 are arithmetically additive (always positive)." The first of these contradictory statements is the correct one. The confusion finally culminates in Krueger's explicitly redefining "synergistic" as synonymous with "additive," thereby enabling the conclusion to be drawn that my expressed preference for additive effects (my definition) is really a preference for synergistic effects (his definition) when I profess to shun synergistic effects (my definition).

(e) Krueger undertakes to demonstrate the "absurdity" of my statement, viz., that the procedure used to establish the chemical ventilation equation would have yielded a zero coefficient if either H-ions or pCO_2 *alone* were influencing ventilation. It is pertinent to remark that the procedure employed was not described in the *Science* report which Krueger read. His "demonstration" consists of replacing $BHCO_3$ for pCO_2 in the equation, leaving *two* essential variables still present, and thus confirming my statement that one variable alone does not account for the experimental data.

(5) Krueger takes exception to my analysis of the respiratory response to exercise because I assumed that metabolism is not increased by passive exercise. This analysis was adequately labeled as incomplete and preliminary; the tentative nature of the *quantitative* values was indicated. The *qualitative* validity of the conclusions requires only that passive exercise produce less increase in metabolism than in ventilation in comparison with active exercise.

(6) It is claimed that in referring to Nielsen's theory I state "categorically" that a unique potency of CO_2 is denied by the fact that Nielsen obtained a response to both acid and CO_2. My statement was that the occurrence of responses to both agents denied the conclusion Nielsen drew from them, namely, that only *one* was a potent stimulus. Krueger further states that I "overlooked" the fact that the injection of acid causes hypercapnia, which could be responsible for the respiratory response to the acid. The truth is that I have analyzed the acute responses to injected acid in detail (*4*). Unfortunately, Krueger seems to have "overlooked" the fact that Nielsen did *not* inject acid, but fed NH_4Cl and that he observed *acapnia* (as have all others) and not hypercapnia.

The title I selected for my theory has turned out to be an unfortunate one, in that it does not adequately distinguish it from other theories. The consequences have been that the theory is superficially judged to be no different from others, since its title can be appropriately applied to others. Many theories have included multiple *factors* presumed to operate by controlling the concentration of a unique stimulus or by controlling the sensitivity of the respiratory center to a unique stimulus. The multiple factor theory differs from these in that it postulates multiple *stimuli* exerting individual or partial effects. Gesell's and Nielsen's theories, therefore, are appropriately classified as multiple factor theories, and mine might better have been called the multiple stimulus theory.

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3. Gray, J. S. AAF School of Aviation Medicine, Project No. 386, Report No. 1, May 7, 1945.
4. Gray, J. S. AAF School of Aviation Medicine, Project No. 386, Report No. 2, December 14, 1945.
5. Gray, J. S. AAF School of Aviation Medicine, Project No. 386, Report No. 3, November 21, 1945.
6. Gray, J. S. *Science*, 1946, **103**, 739-744.

Chemical Research Conferences, AAAS, 1947:

Colby Junior College, New London, New Hampshire, June 16–August 22

W. George Parks, ***Director,***
Rhode Island State College, Kingston

INFORMATION ON THE CHEMICAL RESEARCH Conferences for 1947 with respect to location, purpose, and registration was published in the preliminary announcement in *Science* (March 14, 1947).

Requests for attendance at the Conferences or for any additional information should be addressed to W. George Parks, Department of Chemistry, Rhode Island State College, Kingston, Rhode Island. From June 15 to August 20, 1947, mail should be addressed to Colby Junior College, New London, New Hampshire.

The final program follows:

Organic High Polymers

C. C. Price, Chairman; W. O. Baker, Vice-Chairman

June 16 C. S. Marvel, "New Monomers for Synthetic Rubber"; R. L. Frank and Norman Rabjohn, "Structure of Synthetic Rubbers."

June 17 G. S. Whitby, "Proliferous Polymerization of Butadienes"; John Rehner, Jr., "The Polyisobutylene Reaction."

June 18 A. J. Warner, "New Polymers"; H. Mark, "Cyclo-octotetraene."

June 19 A. V. Tobolsky, "Aging and Degradation of Polymers"; E. H. Farmer, "Thermally-promoted Olefinic Reactivity and Polymerization."

June 20 M. G. Evans, The University, Leeds (tentative).

Catalysis

Walter G. Frankenburg, Chairman; H. S. Taylor, Vice-Chairman

June 23 Aristid V. Grosse, "Concept of Catalytic Chemistry"; H. S. Taylor, "New Data on the Heterogeneity of Catalytic Surfaces."

June 24 James B. Sumner, "Chemical Nature of Biocatalysts; Problems Concerned With the Isolation of Enzymes"; Paul H. Emmett, "Adsorption of Carbon Monoxide and Hydrogen on Carbided Iron Catalysts."

June 25 Otto Beeck, "Thermodynamic and Mechanical Statistical Aspects of Catalysis"; Thomas W. DeWitt, "Mechanism Studies with C^{14} on Iron Fischer-Tropsch Catalysts"; P. W. Selwood, "Magnetochemistry and the Structure of Catalytically Active Solids."

June 26 Marion Armbruster, "Sorption of Gases on a Plane Surface of Stainless Iron-Chromium-Nickel Alloys at 20°, −78°, and −185°C."; M. Jellinek, I. Frankuchen, R. Ward, and M. Erchak, "X-Ray Diffraction in the Study of Catalysts."

June 27 Herman E. Ries, Jr., "Adsorption Studies of Some Supported Catalysts and Their Supports."

PETROLEUM

W. G. Lovell, Chairman; O. Beeck, Vice-Chairman

June 30 F. D. Rossini, "Hydrocarbons in Petroleum"; S. S. Kurtz, "Analysis of Petroleum Products for Hydrocarbon Types."

July 1 H. M. Smith, "Survey of Composition of American Petroleums"; A. C. Fieldner, "Synthetic Fuels and Shale Oil."

July 2 Clark Goodman, "Physical and Chemical Changes Produced by Nuclear Radiations"; A. M. Rothrock, "Power Production From Petroleum."

July 3 J. R. Bowman, "Theory of Distillation and Related Separation Processes"; Manson Benedict, "Diffusion Separation Processes."

July 4 O. Redlich, "Azeotropic and Extractive Separations."

TEXTILES

W. A. Sisson, Chairman; Ross C. Whitman, Vice-Chairman

July 7 Eugene Pacsu, "Molecular Structure of Cellulose and Its Relationship to Chemical Degradation"; Clifford B. Purves, "Some Aspects of the Chemical Reactivity of Cellulose."

July 8 John A. Howsmon, "Fine Structure, Moisture Regain, and Physical Properties of Rayon"; R. F. Nickerson, "Reaction of Cellulose With Formaldehyde Compounds and Its Effect on Fiber Properties."

July 9 Alfred E. Brown and Milton Harris, "Natural Protein Fibers"; Harold P. Lundgren, "Synthetic Protein Fibers."

July 10 Charles F. Goldthwait, "Swelling of Cotton and Its Utilization in Water-resistant Fabrics"; J. H. Dillon, "Harold DeWitt Smith Memorial Program"; A. K. Schneider, "Sorption of Acid Dyes by Nylon."

July 11 Earl K. Fischer and Charles H. Lindsley, "Rheological Properties of Compositions Used in the Textile Industry."

CORROSION

K. G. Compton, Chairman; I. A. Denison, Vice-Chairman

July 14 H. H. Uhlig, "Electrochemical Theory of Corrosion"; R. B. Mears, "Factors Affecting the Rate of Atmospheric Corrosion."

July 15 W. S. Loose, "Atmospheric Corrosion of Light Metals"; R. H. Brown, "Atmospheric Corrosion of Light Metals"; A. W. Tracy, "Atmospheric Corrosion of Nonferrous Metals"; W. E. Campbell, "Indoor Atmospheric Corrosion of Nonferrous Metals."

July 16 Harry R. Copson and W. O. Binder, "Atmospheric Corrosion of Iron and Ferrous Alloys"; C. H. Sample, "Atmospheric Corrosion of Metallic Protective Coatings."

July 17 I. A. Denison, "Underground Corrosion"; R. B. Hoxeng, "Cathodic Protection of Underground Structures by Means of Light Metals."

July 18 R. L. Starkey, "Bacteria and Underground Corrosion"; Paul Weir, "Water Supply Corrosion Tests; A Ten-Year Progress Report."

MEDICINAL CHEMISTRY

E. H. Northey, Chairman; J. M. Sprague, Vice-Chairman

July 21 ENZYME CHEMISTRY: Carl Vestling, "General Survey"; Sherman Dickman, "Fatty Acid Oxidation"; I. C. Gunsalus, "Transformations of Amino Acids"; M. E. Krahl, "Enzymes for Carbohydrate Utilization in Animal Tissue."

July 22 ANTIBIOTICS: Karl Folkers, "Chemistry of Streptomycin"; C. J. Cavallito, "Antibiotics From Plants"; O. Wintersteiner, "Some Aspects of Penicillin Chemistry."

July 23 (*a*) CURARE AND CURARE-LIKE DRUGS, (*b*) FOLIC ACID: J. D. Dutcher, "Chemistry of Curare Alkaloids"; A. R. McIntyre, "Theories of Curarization"; James M. Smith, Jr., "Chemistry of Folic Acid and Related Substances."

July 24 VETERINARY MEDICINE: W. A. Hagan, "Problems for Chemotherapeutic Research in Veterinary Medicine"; A. O. Foster, "Incidence and Treatment of Parasitic Diseases"; Emanuel Waletzky, "Chemotherapy of Coccidiosis."

July 25 TUBERCULOSIS: Guy P. Youmans, "Testing of Tuberculostatic Agents *in Vitro* and in the Mouse"; W. H. Feldman, "The *in Vivo* Evaluation of Substances Effective Against the Tubercle Bacillus."

VITAMINS

D. W. Woolley, Chairman; Floyd S. Daft, Vice-Chairman

July 28 P. L. Harris and E. L. Hove, "Treatment of Experimentally Induced Stomach Ulcers With Tocopherol"; N. B. Guerrant, "Recent Developments in Vitamin A Standardization and Assay"; W. Trager, "A Fat-soluble Substance With Biotin Activity and Its Relation to the Course of Avian Malaria."

July 29 H. R. Bird, "Studies on an Unknown Growth Factor in Cow Manure"; C. A. Cary and A. M. Hartman, "I. Evidence of the Existence of a Still Unidentified Growth Factor in the Nutrition of the Rat. II. Relation Chemically and Nutritionally to Protein, and Occurrence in Variously Prepared Caseins and Other Sources of Protein"; D. W. Woolley, "Strepogenin."

July 30 W. E. Knox, "Identification of New Metabolites of Nicotinic Acid"; D. M. Bonner, "Precursors in the Biosynthesis of Nicotinic Acid"; G. Goldsmith and H. P. Sarett, "Interrelationship of Tryptophane and Nicotinic Acid Metabolism in Man."

July 31 J. Schultz and G. T. Rudkin, "Requirements for Growth of *Drosophila* on the Chemically Defined Medium"; G. Fraenkel, "Nutritional Requirements of Insects"; C. N. H. Long, "Relation of Ascorbic Acid to Adrenal Cortical Function."

August 1 W. D. Salmon, D. H. Copeland, and R. W. Engel, "Production of Neoplasms as a Result of Prolonged Choline Deficiency"; T. Gillman, "Pathological Reactions Encountered in the Livers of Malnourished South African Negroes, With Some Observations on the Response of the Hepatic Lesions to Therapy as Revealed by Serial Aspiration Biopsies."

Food and Nutrition

Lawrence Atkin, Chairman; P. L. Harris, Vice-Chairman

August 4 Gerald J. Cox, "Caries and Nutrition in Human Subjects"; James H. Shaw, "Diet and Experimental Caries"; Discussion leader, Philip Jay. Curt P. Richter, "Self-Selection of Diets"; Heinrich Waelsch, "Nutrition and Brain Function"; Discussion leader, Edward M. Scott.

August 5 H. N. Brocklesby and C. E. Lane, "Some Aspects of the Physiology of Vitamin A"; Discussion leader, H. Sobotka. Walter O. Lundberg, "Food Antioxidants—Fat Soluble"; Roy W. Riemenschneider, "Water-soluble Antioxidants"; Discussion leader, Philip L. Harris.

August 6 Abraham White, "Nutrition and Endocrine Function"; Paul György, "Diet, Liver and Sex Hormones"; Discussion leader, to be announced. Lemuel D. Wright, "Intestinal Microorganisms and Animal Nutrition"; Milicent L. Hathaway, "Intestinal Synthesis of Food Factors Essential for Human Nutrition"; Discussion leader, to be announced.

August 7 M. L. Anson, "Sugar-Protein Reaction, Significance and Methodology"; Earl R. Stadtman, "Chemistry of the Sugar-Protein Reaction"; Discussion leader, J. P. Kass. Donald K. Tressler, "Enzymes in the Food Industry"; Z. I. Kertesz, "Pectins and Pectic Enzymes"; Discussion leader, Carl R. Fellers.

August 8 H. H. Mitchell, "Evaluation of Proteins and Hydrolysates *in Vivo*"; R. J. Block, "Evaluation of Proteins and Hydrolysates *in Vitro*"; Discussion leader, D. Melnick.

Cancer

A. M. Brues, Chairman; Paul S. Henshaw, Vice-Chairman

August 11 Chairman, A. M. Brues. W. H. Summerson, H. Gilder, and J. M. Lee, "Metabolic and Enzymatic Characteristics of Lymphosarcoma"; Symposium on Nucleic Acid Metabolism, Samuel Graff and Hardin B. Jones.

August 12 Chairman, Paul C. Aebersold. Symposium on Radioactive Isotopes in Therapy of Malignant Disease. Paul F. Hahn and C. W. Sheppard, "Radioactive Colloidal Sols"; Rulon W. Rawson, "Radioactive Iodine"; Byron E. Hall, "Radioactive Phosphorus"; Anna Goldfeder, "Radiation Effects on Normal and Malignant Tissues."

August 13 Chairman, Chester Stock. Round Table Discussions on Methods and Results in Chemotherapy of Malignant Disease, Joseph Burchenal, B. E. Hall, D. A. Karnofsky, Robert Mellors, Richard Ormsbee, F. S. Philips, E. B. Schoenbach, C. L. Spurr, K. Sugiura.

August 14 Chairman, Gray H. Twombly. Symposium on Carcinogenic Action of Acetylaminofluorene, K. E. Paschkis and A. Cantarow; H. P. Morris, C. S. Dubnik, T. B. Dunn, J. W. Thompson and B. B. Westfall, V. Suntzeff, "Influence of Aging on Development of Epidermal Cancer"; Roy Hertz, "Inhibition of Estrogen-induced Tissue Growth by Progesterone."

August 15 Chairman, Paul S. Henshaw. Mark W. Woods and H. G. DuBuy, "Similarity of Action of Chondriogenes and Viruses"; P. A. Gorer, "Antibody Responses in Transplanted Tumors."

Instrumentation

C. O. Fairchild, Chairman; J. C. Peters, Vice-Chairman

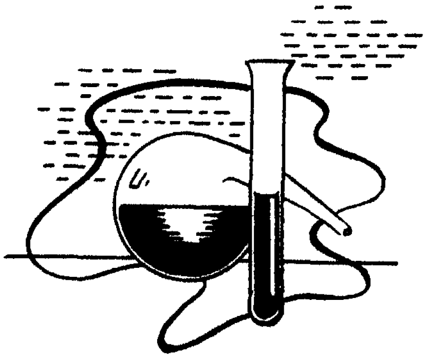
August 18 Robert B. Jacobs, "High-Vacuum Measurement and Control"; R. L. Garman, "Physical Properties Not Commonly Used in Indirect Measurement"; C. M. Albright, Jr., and C. H. Neilsen, "Unsolved Control Problems of the Chemical Industry."

August 19 Ralph H. Müller, "Electronics in Modern Analytical Chemistry"; Donald P. Campbell, "Practical Application of Automatic Control Theory"; Ralph E. Clarridge, "Organization and Functions of an Application Engineering Department."

August 20 Norman Wright, "Application of Infrared Measurements in Industry"; John J. Grebe, "Application of Control Principles to Human Behavior."

August 21 James J. Lingane, "Polarography"; J. C. Mouzon, "Low-Temperature Radiation Pyrometry in Industry."

August 22 W. J. Eckert, "Field of Usefulness of Various Mechanical and Electrical Calculators."



NEWS
and Notes

The Franklin Institute celebrated its 1947 Medal Day at a presentation dinner in Franklin Hall, Philadelphia, on April 16 honoring 19 medalists. The highest award of the Institute, the Franklin Medal, was presented to Enrico Fermi, Institute for Nuclear Studies, University of Chicago, and Sir Robert Robinson, Oxford University, England. Dr. Fermi, who received the 1938 Nobel Prize in physics for his early work in production of transmutations by neutron bombardment, spoke briefly on the opportunities offered by recent developments in the field of nuclear physics to add to and integrate what is now known about the nature of forces within the atom. Sir Robert, who received the award for his contributions in the field of chemistry of natural substances, spoke on the value of concerted research as exemplified by the history of the development of penicillin.

The Ballantine Medal was awarded to George C. Southworth, Bell Telephone Laboratories, the Newcomen Medal, to Everett G. Ackart, recently of the Du Pont Company, the Clamer Medal, to Edgar H. Dix, Jr., Aluminum Company of America; the Brown Medal, to Karl P. Billner, Vacuum Concrete, Inc.; the Clark Medal, to Edward G. Boyer, Philadelphia Electric Company; the Wetherill Medal, to Kenneth S. M. Davidson, Stevens Institute of Technology; Henderson Medals, to Lars O. Grondahl, Union Switch & Signal Company, and Sedgwick N. Wight, General Railway Signal Company; Levy Medals, to Everett M. Barber and Jay B. Malin, both of the Texas Company, and Joseph J. Mikita, the Du Pont Company; Potts Medals, to Robert H. Kent, Aberdeen Proving Ground, and Vladimir K. Zworykin, Radio Corporation of America; Longstreth Medals, to Samuel Berman, Waugh Equipment Company, and Harold J. W. Fay, Submarine Signal Company; and Certificates of Merit, to Joseph Razek, Llanerch, Pennsylvania, and Peter J. Mulder, Shippensburg State Teachers College.

About People

Enrico Fermi, Nuclear Research Institute, Chicago, has been named honorary chancellor of Union University, Schenectady, New York, for 1947–48, an office conferred annually since 1878 on such outstanding leaders as Wendell Willkie, Bernard Baruch, Irving Langmuir, President Taft, Chief Justice Hughes, Elihu Root, Whitelaw Reid, and Senator Vandenburg.

George W. Carter, head of the Physics Department, Wayne University, since 1917, has been retired at his own request by the Detroit Board of Education.

R. W. Trullinger, chief of the Office of Experiment Stations, Department of Agriculture, has been appointed assistant administrator of the Agricultural Research Administration. Dr. Trullinger will continue as chief of the Office of Experiment Stations, so that the office will be brought into closer contact with the over-all planning of research in the Department.

James A. Noble, chief geologist of the Homestake Mining Corporation, has been granted a leave of absence by the Corporation in order to serve as professor of metalliferous geology at the California Institute of Technology, starting September 1, 1947. Dr. Noble succeeds H. J. Fraser, now general manager of the Falconbridge Nickel Mining Company.

Richard H. Daggy, formerly assistant professor of entomology at the University of Minnesota, has been appointed medical entomologist for the Arabian American Oil Company. Dr. Daggy's headquarters will be at Dhahran, Saudi Arabia.

B. S. Pickett, head of the Department of Horticulture and of the horticultural section of the Agricultural Experiment Station, Iowa State College, for 24 years, will retire June 30 but will continue as professor in the department. He will be succeeded by E. S. Haber, head of the vegetable crops subsection.

Clinton M. Osborn, Department of Anatomy, College of Medicine, Ohio State University, has been appointed associate professor of zoology, Syracuse University, effective September 1, 1947. Dr. Osborn was formerly associated with the Biological Laboratories of Harvard University, where he received his Ph.D. degree, and during the war was a Major in the Aviation Physiology service of the U. S. Army.

Robert A. Moore, professor of pathology at Washington University School of Medicine since 1939 and acting dean of the School for the past year, has been appointed dean. Dr. Moore is secretary of the American Board of Pathology and editor of the *Journal of Gerontology*. During the war he served as civilian resident consultant to the Army Medical Museum and to the Secretary of War on epidemic diseases.

Cornelia T. Snell, Snell Laboratories, New York City, will speak on "Synthetic Detergents" May 5 at The Pennsylvania State College in the annual Marie Curie Lecture Series sponsored by the Palladium Chapter of Iota Sigma Pi, national honor society for women in chemistry.

Harold C. Wiggers, associate professor of physiology, University of Illinois College of Medicine, has been appointed head of the Department of Physiology and Pharmacology, Albany Medical College, and will assume his duties on July 1.

P. J. Selgin, 35-year-old expert in high-frequency radiation and electronics, has been appointed to the staff of the National Bureau of Standards, where he will work on the development of electronic ordnance for the military services in the Ordnance Development Division.

Grants and Awards

Hubert Lyman Clark, associate professor emeritus of zoology at Harvard University, is the recipient of the 1946 Clarke Memorial Medal, one of Australia's leading scientific honors, awarded by the Royal Society of New South Wales. The medal is presented for distinguished work in the natural sciences performed in the Australian Commonwealth or its territories. Dr. Clark was "unanimously agreed upon because of the great interest in Australian zoological problems, particularly in regard to the elucidation of the Echinodermata of the country."

Linus Pauling, director of the Gates and Crellin Laboratories of Chemistry, California Institute of Technology, has been awarded the Theodore William Richards Medal of the Northeastern Section of the American Chemical Society. Dr. Pauling was especially cited for his work in quantum mechanics, valence theory, crystal structure, electron diffraction, and biochemistry. The award will be presented at a meeting of the Northeastern Section on May 8.

Barbara McClintock, Department of Genetics, Carnegie Institution, Cold Spring Harbor, New York, received the $2,500 achievement award of the American Association of University Women at the Association's convention in Dallas, Texas, April 18. Dr. McClintock received the award in recognition of her work in the field of cytogenetics.

Wolfgang Koehler, Swarthmore College, received the Howard Crosby Warren Medal and Award at a meeting of the Society of Experimental Psychologists on April 9. Dr. Koehler was cited "for his studies on figural after effects as an approach to a more general theory of perceptual processes."

Brig. Gen. George R. Callender, U. S. Army (retired), has been awarded the United States of America Typhus Commission Medal for exceptionally meritorious services in organizing, directing, and supporting investigations of the rickettsial diseases, in training personnel in organizing a laboratory for the study of these diseases, and in aiding and supporting the Commission.

Julian I. Gilliam has received the first in a series of fellowships to be awarded by the Virginia Cancer Foundation for a year of training in cancer work at Bellevue Hospital under supervision of New York University College of Medicine doctors.

The American Veterinary Medical Association has announced the renewal of the following fellowships for 1947–48: Howard W. Dunne, working at Michigan State College on swine enteritis; Dean S. Folse, working at the University of Minnesota on coccidiosis in turkeys; and Melvin J. Swenson, working at Iowa State College on nutrition and its effects on diseases of swine. The renewals, together with new fellowships for 1947–48 which will be announced upon acceptance by the winning candidates, were awarded by the Fellowships Committee of the Association's Research Council at a meeting in Chicago on April 12. All funds for this program are derived from contributions from veterinarians.

The American Philosophical Society has awarded fellowships from the Penrose Fund to the following candidates for their respective studies: Victor F. Hess, Fordham University, actual ionization produced by the gamma rays from well-analyzed types of rocks; L. Reed Brantley, Occidental College, acidic and oxidizing properties of oxygen fluoride in aqueous solution and in the gaseous state; Lewis H. Kleinholz, Reed College, endocrine and nervous factors in the regulation of hyperglycemia in crustaceans; Thos. A. Stephenson, University of Miami, general biology of animals and seaweeds between tide marks; George L. Kreezer, Institute for Advanced Study, determination of the components of biological systems on the basis of the mathematical analysis of transient response curves; Ching-tsao Wei, University of Nanking, (1) a survey of the seed-borne pathogens of soybean in North and Central China and (2) a study on the relative effectiveness of treatments with organic mercury dusts and hot water; David H. Raab, Brooklyn College, neurology of hearing and auditory learning in animals; and T. C. Schneirla, American Museum of Natural History, behavior pattern of army ants in relation to underlying ecological and physiological conditions.

Colleges and Universities

The University of Tennessee has announced the following appointments to its chemistry staff: Evan C. Noonan, Westvaco Chlorine Products, Inc., as associate professor, and George P. Mueller, Wyeth Institute of Applied Biochemistry, as assistant professor.

The University of Michigan has announced the following appointments for the academic year 1947–48: Donald D. Brand, professor of geography; George M. Sutton, half-time curator of birds in the Museum of Zoology and associate professor of zoology; and Richard K. Beardsley, instructor in anthropology. The following leaves of absence were also announced: Leslie A. White, professor of anthropology, for the first semester, to do research on the evolution of culture; Mischa Titiev, associate professor of anthropology, for the second semester, to make use of a grant from the Rackham Research Foundation for the study, in Chile, of the changing pattern of Araucanian culture; and Shirley W. Allen, professor of forestry, for the first semester, to do research in forest administration and in the general field of conservation of natural resources.

The University of Pennsylvania School of Medicine has announced that as of July 1, 1947, T. Grier Miller, Truman G. Schnabel, and Charles C. Wolferth, who now hold full professorships in clinical medicine, will become full professors in medicine. Francis C. Wood, assistant professor in medicine, will become full professor and chairman of the Department of Medicine, succeeding O. H. Perry Pepper, who has asked to be relieved of his administrative duties.

Summer Programs

The Franz Theodore Stone Laboratory, of Ohio State University, will offer 18 courses of advanced study in botany, entomology, and zoology during its summer quarter, beginning June 16. The station, operating as a regular department of the University, maintains a departmental library and a full-time staff. Living accommodations include a men's dormitory, a women's dormitory, and a residence hall for married students. Registration for the summer quarter will be held at the Laboratory on June 16, but those interested in attending are advised to submit applications as soon as possible to Dr. Thomas H. Langlois, Director, Franz Theodore Stone Laboratory, Put-in-Bay, Ohio.

The University of California Medical School, in association with University Extension, University of California, announces a course in the Application of Nuclear Physics to the Biological and Medical Sciences, to be given at the Medical Center, San Francisco, June 30–July 18. The course will consist of didactic lectures, laboratory demonstrations, and seminars for round-table discussions and will be open to individuals in the fields of medical and biological research. Detailed information may be obtained from: Dr. Stacy R. Mettier, Head, Postgraduate Instruction, Medical Extension, University of California Medical Center, San Francisco 22, California.

Duke University Marine Laboratory, Beaufort, North Carolina, is offering two courses for graduate students and qualified seniors this summer. Marine Zoology will be given during the first term, June 12–July 24, by C. G. Bookhout; Plant Ecology, during the second term, July 25–August 29, by H. J. Oosting. Opportunities for research in marine botany or zoology and local flora or fauna will be offered graduate students throughout the summer.

Industrial Laboratories

The General Electric Research Laboratory announces the appointment of Glenn T. Seaborg, professor of chemistry, University of California, and co-discoverer of the artificial element, plutonium, as a consultant in nucleonics.

Pyridium Corporation, Yonkers, New York, has announced the following appointments: John F. Reinhard, formerly with the Burroughs Wellcome Company, Tuckahoe, New York, as a pharmacologist; and Charles F. Duca, formerly instructor of bacteriology, College of Physicians and Surgeons, Columbia University, as a bacteriologist.

Elections

The New York State Archaeological Association, at a meeting at the Rochester Museum of Arts and Sciences on April 12, elected Carl E. Guthe director, New York State Museum, as president and Charles F. Goddard as first vice-president.

The Southern New England Chapter of the Soil Conservation Society of America, at its organizational meeting on March 8, elected the following officers: Ayers Brinser, chairman; Irene H. Stuckey, vice-chairman; Laurence T. Small, treasurer; and L. Russell Albright, secretary.

George R. Harrison, dean of the School of Science, Massachusetts Institute of Technology, has been elected chairman of the American Institute of Physics, succeeding Paul E. Klopsteg, director of research, Northwestern University Technological Institute, who has served as chairman since 1940.

Meetings

The American Society for the Study of Arteriosclerosis, now being organized, will hold its constituting meeting June 9 at the Hotel Strand, Atlantic City, New Jersey. Clinicians and experimentalists interest in a concerted investigation of all phases of the disease are invited to join and are urged to communicate as soon as possible with Dr. O. J. Pollak, Wilmington General Hospital, Chestnut and Broom Streets, Wilmington 14, Delaware.

The American Association of Physics Teachers and **The American Society for Engineering Education** will meet jointly at the University of Minnesota, Minneapolis, June 18–21. The program chairmen for the meeting, C. E. Bennett and J. W. Buchta, are planning a symposium on the teaching of physics, particularly as it relates to students in electrical engineering. Complete programs for the meeting may be obtained after May 10 from C. J. Overbeck, Secretary, American Association of Physics Teachers, Physics Department, Northwestern University, Evanston, Illinois. Members planning to attend the meeting are urged to make hotel reservations as soon as possible through the Hotel Association of Minneapolis.

The Acoustical Society of America will meet at the Pennsylvania Hotel, New York, May 8–10. This meeting, which will be concerned chiefly with the means of attaining closer correlation of the art of music and the science of acoustics, will feature the following speakers: Howard Hanson, Eastman School of Music, Rochester, New York; Harvey Fletcher, Bell Telephone Laboratories; Harold Burris-Meyer, Stevens Institute of Technology; Leopold Stokowski; Gustave Reese, American Musicological Society; and V. O. Knudsen, University of California, Los Angeles.

The Association of Geology Teachers will hold its annual meeting May 9–10 at Milwaukee-Downer College, Milwaukee, Wisconsin. In addition to presentation of papers, the program will include the presidential address of Neil A. Miner, Cornell College; a discussion on "What the Graduate School Expects of the Undergraduate," led by Arthur L. Howland, Northwestern University; the annual banquet and lecture; and either a field trip to Silurian and Devonian localities or a visit to the Milwaukee Public Museum. Those interested in attending should communicate with Miss Katherine F. Greacen, Secretary, Milwaukee-Downer College, Milwaukee 11, Wisconsin.

The Society of American Bacteriologists, meeting May 13–16 at the Bellevue Stratford Hotel in Philadelphia, will honor Ludvig Hektoen at its 1947 annual lecture. The lecture, which has been scheduled for the morning of May 14, will be delivered by William H. Taliaferro, University of Chicago, on "The Inhibition of Reproduction in Parasites by Immune Factors."

The Division of Solid State Physics of the American Physical Society, now in the process of formation, will meet in Montreal on June 21, according to an announcement by the Organizing Committee. This date was selected for the convenience of those who will attend meetings of the American Physical Society in Montreal, June 19–21, and of the American Society for X-Ray and Electron Diffraction near Montreal, beginning June 23. In addition to contributed papers in the field of solids, the program will include four invited papers: "Diffraction of Neutrons in Crystals," F. Seitz; "Theory of Crystal Rectifiers With Application to Copper Oxide," J. Bardeen; "The Relaxation Spectrum of Metals," C. Zener; and "Nuclear Magnetic Resonance Absorption in Solids and Liquids," E. M. Purcell.

Members of the Organizing Committee of the Division are: T. A. Read, F. Seitz, W. Shockley, S. Siegel, R. Smoluchowski, and C. Zener.

The American Iron and Steel Institute will hold its 55th general meeting in New York at the Hotel Pierre on May 21 and at the Waldorf-Astoria on May 22. One of the features of the program will be the first Charles M. Schwab Memorial Lecture, to be delivered by Eugene G. Grace, Bethlehem Steel Company. Four technical sessions are planned as follows: "Raw Materials," "Coke Ovens, Blast Furnaces and Steelmaking Furnaces," "Shaping and Forming," and "General Metallurgy." Members are urged to address all communications with reference to luncheon and dinner reservations to: S. A. Maxon, Assistant Secretary, American Iron and Steel Institute, 350 Fifth Avenue, New York 1, New York.

Recent Deaths

Herbert S. Jennings, 79, research associate at the University of California since 1938 and professor emeritus of zoology at Johns Hopkins University, died April 14 in Santa Monica, California, after a year's illness.

Halsey J. Bagg, 57, research biologist who had devoted much of his life to the study of cancer, died April 13 in Yorktown Heights, New York.

William Stanley Marshall, 80, professor emeritus of zoology at the University of Wisconsin, died March 17 in Madison. He published many papers on the anatomy and embryology of insects. A collection of Wisconsin beetles, which he assembled, was left to the University of Wisconsin.

I. Seymour A. Hadwen, 70, former director of the Department of Pathology and Bacteriology, Ontario Research Foundation, and past-president of the American Veterinary Medical Association, died April 18 in Toronto.

Make Plans for—

New York State Geological Association, 19th field meeting, May 9–10, New York City.

Federation of American Societies for Experimental Biology, May 18–22, Chicago, Illinois.

American Association of Cereal Chemists, 32nd annual meeting, May 19–23, Hotel President, Kansas City, Missouri.

American Oil Chemists' Society, 38th annual meeting, May 20–22, New Orleans, Louisiana.

American Society of Mechanical Engineers, oil and gas power 19th national conference, May 21–24, Cleveland, Ohio.

COMMENTS

by Readers

A number of biological papers involving work in which a centrifuge is used are published each year. In an appreciable percentage of these, reference to the amount of centrifuging to which a given material is subjected is presented in terms of duration of centrifuging and the speed of the centrifuge. Such figures, alone, are quite meaningless. Centrifuging data should include duration of centrifuging and the magnitude of the applied centrifugal force. It is possible to centrifuge material at 3,000 r.p.m. (or even at 3,000 r.p.s.) and subject it to little or no centrifugal force, if the material is near or at the center of rotation.

The centrifugal force, in terms of gravity, can be easily calculated if one knows the speed of the centrifuge and the distance of the material from the center of rotation. Heilbrunn (1921) gives the formula

$$c' = \frac{4\pi^2 n^2 r}{g},$$

where n = the number of revolutions per second, r = the distance of the material from the center of rotation in centimeters, g = the gravitational constant, and c' = the centrifugal force in terms of gravity. The figure 39.478 may be substituted for the constant $4\pi r$. Shapiro (1935) has published a useful monogram for obtaining c' if n and r are known.

It is important to stress the fact that r represents the distance of the material from the center of rotation and not the length of the centrifuge arm or the external radius of the centrifuge. The centrifugal force at the outer periphery may be far greater than the effective force, since the material being centrifuged is nearer the center of rotation by the thickness of the outer wall of the centrifuge plus the thickness of the bottom of the centrifuge tube plus the thickness of the layer of supporting medium (if present).

Furthermore, it is not sufficient to state the speed of the centrifuge and the type of centrifuge employed, since most centrifuges have interchangeable heads of different diameters. It is true that, for any given centrifuge with a given head, the speed of rotation and the duration of centrifuging are the variables and the distance of the material from the center of rotation is usually constant. Nevertheless, the latter can be varied by changing the centrifuge head or by altering the method of suspending the material in the centrifuging medium.

Editors could do much to remedy the present situation by insisting that authors either state the centrifugal force employed or give both the speed of the centrifuge and the effective distance from the center of rotation. The former procedure is definitely preferable, however, since it is more concise, saves the reader a task of calculation, and avoids the possibility of subsequent misquotation in terms of centrifugal speed alone.

If the centrifugal force employed in a given set of experiments, particularly on such material as living marine egg cells, is unknown, it is frequently impossible to repeat these experiments and obtain the same result. Rate of sedimentation of the granules and vacuoles of living cells under low centrifugal forces is markedly retarded by redistribution of these inclusions by Brownian movement, as Howard (1931) carefully pointed out.

Among the numerous pieces of work on biological material marred by the oversight of stating centrifugal speed rather than centrifugal force, or entirely omitting mention of magnitude of centrifugal force employed, are those of Boveri (1910), Hertwig (1904), Morgan (1935, 1937), Parseval (1922), Raven (1938), Ries (1939), Wilber (1945), Wilson (1929, 1930), and many others. (DONALD P. COSTELLO, *Department of Zoology, University of North Carolina, Chapel Hill.*)

TECHNICAL PAPERS

Effect of Intraperitoneal Injection of Malignant Urine Extracts in Normal and Hypophysectomized Rats

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Lipid extracts of normal liver tissue and those from histologically normal liver and other tissues from malignant patients, when injected into rats and mice, cause the appearance of tumors in a number of the animals (*3*). The active factor resides in the nonsaponifiable sterol fraction.

Some time ago we began a study of alcohol-ether extracts of known malignant urines with the hope of producing tumors in rats receiving 2 cc. of these extracts, equivalent to 100 cc. of original urine. It was found, however, that 2 to 4 days after injection of the extracts there was an enlargement in the spleen and/or gonads. In 39 out of 40 known malignant extracts the decrease in the body weight:spleen and body weight:gonad ratios ranged from 20 to 80 per cent below these same ratios in the control rats with no injection. This constitutes a biological test of malignancy. In 26 normal urine extracts the test was negative (a decrease of not more than 20 per cent from the controls). The average per cent increase in weight of the organs in these 40 cases over that in the controls was as follows: spleen, 39; male gonads, 55; and female gonads, 72. There was intense hyperemia in the spleen and hyperplasia and intense spermatogenesis in the testes.

In 32 urines from patients whose diagnosis was unknown to us at the time the tests were made, there were 6 positive tests, one each from cancer of the breast, rectum, stomach, prostate, colon, and a malignant melanoma. In the remaining 26 cases all were normal or nonmalignant, and the tests in all were negative. These results confirm those of Carratala, Roffo, and Krebs and Gurchot (*1*) in this connection.

The malignant extracts gradually lose their potency if allowed to stand some time in the ice chest. The average decrease in the R/S ratios in fresh extracts was 47 per cent compared to only 17 per cent at the end of four months. These values for the R/G ratios were 61 and 24 per cent.

We believe that a substance, X, which is present in the blood and urine of all malignant patients so far tested, is either a sterol or a sterol-protein complex. Roffo, and Krebs and Gurchot, further stated that a gonadotropic hormone was responsible for the results of the biological test. In order to in-

TABLE 1

	Normal rats							Hypophysectomized rats								
Ext. No.	Rat (grams)	Spleen (mg.)	Gonads (mg.)	R/S	R/G	Decrease (%)		Rat (grams)	Spleen (mg.)	Gonads (mg.)	R/S	R/G	Decrease (%)		Clinical diagnosis Ca of:	Age of extract (mos.)
						R/S	R/G						R/S	R/G		
C	87	267	90	326	966			69	180	282	383	245				
21	85	535	252	158	337	52	65	69	206	292	335	236	13	4	Bronchiogenic Ca	1
C	104	966	1,403	107	74			104	966	1,403	107	74				
21	95	1,073	1,903	89	50	17	32	98	941	1,094	104	90	0	0	Bronchiogenic Ca	4
C	115	868	1,105	132	104			69	180	282	383	245				
28	124	900	2,060	137	60	0	42	80	224	197	357	406	7	0	Breast	1
C	112	1,046	1,501	107	75			112	1,046	1,501	107	75				
28	132	1,216	2,321	108	57	0	24	101	832	1,350	121	74	0	0	Breast	4
C	97	333	87	291	1,114			109	850	1,395	128	78				
34	89	669	335	133	266	54	76	110	785	1,415	140	78	0	0	Prostate	1
C	95	903	1,381	105	69			95	903	1,381	105	69				
34	127	1,365	1,900	93	66	11	0	98	510	1,384	192	71	0	0	Prostate	4
C	107	483	200	221	535			111	863	1,175	128	94			Mediastinum	
37	107	748	530	143	201	35	62	123	915	1,410	134	87	0	7	(Mtas to spine)	1
C	81	680	1,190	119	68			81	680	1,190	119	68			Mediastinum	
37	109	1,160	1,875	93	58	22	15	83	660	946	126	88	0	0	(Mtas to spine)	4

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[1] The authors wish to thank F. C. Koch, director of the Armour Laboratories, for the suggestion to use hypophysectomized rats and for instruction in the use of the Ingle technique of hypophysectomy.

vestigate this point a study was run in which known malignant urine extracts were injected into normal and hypophysectomized rats. The results obtained are listed in Table 1. In this study, 39 out of 40 known malignant urine extracts gave a positive biological test two days after injection. In 32 urines of unknown diagnosis the test was positive in 6 malignancies and negative in 26 nonmalignancies. All urine extracts from normal individuals and other nonmalignant cases were negative.

The following views are supported by the results:

(1) Malignant urine extracts lose about 60 per cent of their ability to give the test after standing in the ice chest for four months.

(2) The biological test is *negative* in the hypophysectomized rat.

(3) *All malignant urines so far tested by ourselves* (*with one exception*) *and others* contain a substance, X, which is protein-sterol or sterol in nature and which stimulates the rat pituitary to produce increased amounts of another substance, Y, possibly a gonadotropic hormone, which is then responsible for the biological test for human malignancy.

The idea given in (*3*) is confirmed by Gurchot, Krebs, and Krebs (*2*), who stated: "The experiments herein described indicate that normal human pregnancy trophoblast (from human placental tissue), when grown in the anterior chamber of the eyes of rabbits, behaves like a malignant tumor grown in a similar medium. Our experiments, as well as those of others, suggest that all malignant tumors, regardless of their protean character, are fundamentally trophoblastic."

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Serum Phosphatases and Alloxan Diabetes[1]

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Alloxan diabetes was produced in adult male albino rats by a single subcutaneous injection of 16 mg. of alloxan monohydrate for each 100 grams of body weight. The animals were housed in metal cages, 6 to a cage, and fed Purina Fox Checkers with tap water *ad lib.* Of 61 animals used, 6 per cent were unaffected by the treatment; 10 per cent recovered from an early hyperglycemia; 20 per cent developed hyperglycemia and died within three days. The remaining 64 per cent survived for long periods and exhibited hyperglycemia, glycosuria, lipemia, and ketonuria. Polyuria and polydipsia were marked, and there was progressive weight loss to the extent of 50 per cent of the original weight in three weeks.

Specimens of tail blood were obtained periodically for the estimation of blood glucose, serum inorganic phosphorus, and acid and alkaline phosphatases. Blood sugar was estimated by the micromethod of Reinecke (*5*). Serum phosphorus and phosphatases were determined by the method of Shinowara, *et al.* (*6*) as modified by Gould and Schwachman (*3*). Acid and alkaline phosphatases were estimated at pH 5.3 and pH 9.3, respectively. The normal mean values, previously determined in fasted animals, were: blood sugar, 117 mg./100 ml.; serum inorganic phosphorus, 9.0 mg./100 ml.; serum acid phosphatase, 3.2 units/100 ml.; and serum alkaline phosphatase, 113 units/100 ml.

Six animals were used for each experiment and the results averaged. Table 1 presents the findings in a representative group.

There is a rapid, progressive rise in blood sugar. This exceeds 400 mg. per cent at the end of two days and is maintained thereafter with only slight fluctuations. The initial transient rise in blood sugar in rabbits noted by some observers (*4*) and attributed to the release of adrenalin was not observed in the present experiment. In our subsequent experiments, not reported here, in which the dosage of alloxan was greater, such an early transient blood sugar rise was observed. The acid phosphatase falls quickly to about 25 per cent of the initial level and returns to normal in three days. Alkaline phosphatase shows a similar initial decline which is restored within 12 hours. This is followed by a progressive increase over the next two weeks, when values in excess of three times the normal level are reached. Serum inorganic phosphorus is not greatly altered, but nearly all values found after the injection of alloxan are greater than the initial levels.

TABLE 1

EFFECT OF ALLOXAN ON BLOOD SUGAR, SERUM PHOSPHATASES, AND INORGANIC PHOSPHORUS

Time after administration of alloxan	Blood sugar (mg./100 ml.)	Serum alkaline phosphatase (units/100 ml.)	Serum acid phosphatase (units/100 ml.)	Inorganic phosphorus (mg./100 ml.)
0 hrs.	123	109	3.6	8.3
2 "	166	—	—	—
3 "	216	56	0.93	—
6 "	—	64	1.0	10.9
9 "	250	89	1.3	9.9
12 "	310	105	1.6	9.1
24 "	380	125	1.7	8.4
2 days	464	154	1.5	8.6
3 "	440	179	3.7	8.9
4 "	425	205	4.2	9.8
5 "	426	223	4.2	10.5
7 "	358	177	4.1	9.4
8 "	412	250	4.0	9.9
14 "	444	365	4.6	9.0
21 "	420	371	3.7	9.3
42 "	437	380	4.4	10.1

The hyperglycemia and ketonuria which develop are easily controlled with insulin. A single subcutaneous injection of 0.4 units of crystalline zinc insulin restores the blood sugar to within normal levels in three hours. This is accompanied by a 30 per cent decline in both acid and alkaline phosphatases. At the end of 24 hours all values are restored to the diabetic levels. In order that the effect of insulin could be observed over a longer period, three doses of 0.4 units of insulin were injected at three-hour intervals. The averaged results in four animals are presented in Table 2.

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[1] This work is part of Project M.P. 80, conducted with the assistance of a grant to M. M. Cantor from the Division of Medical Research, National Research Council, Ottawa.

Blood specimens obtained 90 minutes after the third injection of insulin show hypoglycemia, reduction of acid phosphatase to 25 per cent of normal, and reduction of the alkaline enzyme to within normal limits. Serum inorganic phosphorus is reduced.

TABLE 2

EFFECT OF THREE DOSES OF 0.4 UNITS OF INSULIN AT THREE-HOUR INTERVALS ON BLOOD SUGAR, SERUM PHOSPHATASES, AND INORGANIC PHOSPHORUS IN ALLOXAN-DIABETIC RATS

Time after injection of insulin	Blood sugar (mg./100 ml.)	Serum alkaline phosphatase (units/100 ml.)	Serum acid phosphatase (units/100 ml.)	Serum inorganic phosphorus (mg./100 ml.)
0 hrs.	425	384	3.9	11.8
1st dose				
1½ hrs.	150	340	3.1	11.1
3 "	154	284	2.3	11.5
2nd dose				
1½ hrs.	77	236	2.0	11.5
3 "	101	197	2.4	9.2
3rd dose				
1½ hrs.	51	161	1.0	10.2
3 "	122	132	1.0	9.8
9 "	410	206	2.3	7.4

Our findings indicate that the development of alloxan diabetes in rats is accompanied by an increase in serum alkaline phosphatase activity and that the administration of insulin produces a decrease in the activity of both the acid and alkaline enzymes. The initial decline in phosphatase activity following the injection of alloxan simulates that produced by the injection of insulin and is attributed to the release of insulin stores in the pancreas. When this supply is exhausted, alkaline phosphatase activity increases and remains elevated, the increase being parallel to the elevation in blood sugar. Both are reduced, again in parallel fashion, by the administration of insulin.

We have been unable to demonstrate any great increase in serum inorganic phosphorus following the administration of alloxan, although nearly all the values found were in excess of the preinjection level, and a few were greatly increased. Following the administration of insulin in the alloxan diabetic animal, reduction in the level of inorganic phosphorus was demonstrated. These findings are in accord with the well-known effect of insulin both in the diabetic and normal organisms (*1*, *2*) and suggest that these alterations reflect changes in phosphatase activity.

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The pH Stability of Viruses of Newcastle Disease and Fowl Plague[1]

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The recognition (*2*) of the immunologic identity of the causative agent of avian pneumoencephalitis with that of Newcastle disease revealed the existence of a serious threat to the poultry industry of the United States. The clinical features of the American form of the disease have allayed suspicion of its identity with the classical, hitherto highly virulent Newcastle disease (*1*). The differences between the American and the classical forms may result from the noted marked pneumo- and neurotropism of the virus isolated in this country and the pronounced enterotropism of a European strain of the virus (*7*). In Europe and elsewhere, Newcastle disease has been mistaken for possible forms of fowl plague and vice versa, and immunologic evidence has been obtained to support both dissimilarity (*5*) and similarity (*8*) of these diseases. However, recent immunologic and other comparative studies have provided strong support for the unity of each disease (*4*). The importance of these two diseases, the one a real, and the other a potential, threat to the poultry industry of this country, prompted studies to obtain further information on the relationship of the American and European Newcastle disease viruses and of these, in turn, to the virus of fowl plague.

An evaluation by Doyle (*5*) of the effect of marked acidity and alkalinity on the Newcastle virus infectivity indicated greater resistance to the H- than to the OH-ions. The results of Pyl (*10*) in the case of the fowl plague virus showed that maximal stability of the infectivity occurred between pH 6.3 and 9.1 and that the virus was destroyed immediately at pH 4 and 12.7. This pattern was similar for brain and blood virus of chickens infected with the Brescia and Bologna strains of plague virus. These results and those for other viruses (*6*, *10*) suggested or showed rather distinctive pH stability patterns.

Evaluations of the pH stability were made on four strains of the Newcastle disease virus, including the Hertfordshire strain (H) of English origin and three strains (11914, RO, and C) isolated from cases of "pneumoencephalitis" in California and provided by J. R. Beach, and on the Dutch East Indies strain of the fowl plague virus. A variant virus (Strain 4395), isolated from the plague virus in the course of other procedures (*9*), was subjected to similar study. The source of the virus used in all tests was the allanto-amnionic fluid of embryonated chicken eggs which had been infected with the respective viruses after 10–12 days of incubation. These materials were admixed in the ratio of 1:99, or, in a few tests, 1:9, with portions of a buffer solution (*3*) having pH values of from 2 to

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[1] This work was done as a part of a research project conducted under the direction of a War Department Commission consisting of: Brig. Gen. R. A. Keiser, U. S. Army; B. E. Dyer, U. S. Public Health Service; H. W. Schoening, Pathological Division, Bureau of Animal Industry, U. S. Department of Agriculture; and E. B. Fred, University of Wisconsin.

12; the buffer solutions differed by a gradient of 1 pH and were prepared by the addition of NaOH, HCl, or distilled water so that the final concentrations of buffer salts were the same in all. These mixtures or the dilutions thereof in 1 per cent peptone broth (pH 7.8) were held at 2°–6° C. until used to test for the presence of virus. Infective virus was detected by its activity in 10- to 12-day embryonating chicken eggs following intra-allantoic inoculation. Tests for the virus were conducted at intervals of one hour, one day, and one week following the preparation of the buffer-virus mixtures. The pH values of the mixtures were determined by a glass electrode potentiometer after intervals of one day and one week.

The typical reproducible results obtained with the four strains of the Newcastle disease virus and the fowl plague virus are shown in Fig. 1. These results pertain to virus-buffer mixtures that were made in the ratio of 1:99. It will be noted that definite variations occurred in stability among the strains of Newcastle virus. In the acid range, two of the California strains (RO and C) showed comparable stability patterns, while one strain of this source was somewhat more resistant to acidity and was comparable to the strain (H) of English origin. All four strains were essentially similar in the presence of alkali after exposure for one hour, while infective virus of two of the strains (English and RO) diminished in concentration after one day, and still further variations were demonstrated after one week. A summary consideration of all four strains shows that after one hour a maximal stability existed over the range of approximately pH 4 to pH 11, while survival was possible over the range of pH 2 to pH 12; that after one week a maximal stability could be expected within at least the scale from approximately pH 5 to pH 9; and that survival of the virus should be anticipated approximately from pH 2 to pH 11. These stability ranges were considerably broader than that demonstrable for the virus of fowl plague.

☒	⧄ 2	5	5	6	6	6	5	⧄ 3	☒	☒	H	1 Week
☒	⧄ 3	5	6	6	6	6	7	7	5	☒	11914	
☒	☒	⧄ 3	5	5	5	5	5	5	☒	☒	RO	
☒	☒	⧄ 4	5	6	6	6	6	6	⧄ 2	☒	C	
☒	☒	☒	☒	5	6	6	5	6	6	☒	Plague	
☒	⧄ 4	6	6	6	6	6	6	5	⧄ 3	☒	H	1 Day
☒	⧄ 2	7	7	7	7	7	6	7	6	☒	11914	
☒	☒	4	5	6	5	6	6	5	⧄ 3	☒	RO	
☒	☒	5	6	6	6	6	6	6	6	☒	C	
☒	☒	☒	⧄ .1	6	6	6	6	6	6	☒	Plague	
⧄ 3	5	6	6	6	7	6	6	6	6	⧄ .1	H	1 Hour
⧄ 3	⧄ 4	6	6	7	6	6	7	6	6	☒	11914	
☒	⧄ 1	5	6	5	6	5	6	6	6	☒	RO	
☒	☒	6	5	6	6	6	6	6	5	☒	C	
☒	☒	☒	⧄ 3	6	6	6	6	6	6	⧄ 2	Plague	
2	3	4	5	6	7	8	9	10	11	12	Virus	Time
pH of buffer-virus mixture.												

☒ Virus noninfective.

⧄ Infectivity titer of virus reduced to the given dilution indicated by reciprocal of log.

☐ Infectivity titer of virus not significantly reduced; infectivity titer indicated by reciprocal of log of the dilution lethal for embryos.

Fig. 1

The plague virus was much more sensitive to an acidic environment than the Newcastle virus, but was not distinctly unlike it with respect to alkali. The plague virus survived in maximal titer, after one week, from pH 6 to pH 11; the same maximal stability was demonstrated after exposure to the various pH conditions for one hour, but at this time infective virus was still present at pH 5 and at pH 12.

The pH values of the virus-buffer mixtures made in the ratio of 1:99 were found to drift toward the pH of the virus material (pH 7.8–8), but after one week this did not exceed 0.25 of one pH value in the extreme of the acid range or 0.5 of one pH value in the extreme of the alkaline range.

The results of a comparative study of the pH stability of the plague virus with that of a variant virus isolated from it are shown in Fig. 2. The ratio of quantity of virus material to that of buffer employed here was 1:9. The stability patterns of the infectivity of both of these viruses were essentially similar; the differences that occurred between them are attributed to the lower concentration of the variant strain of virus that was attainable and/or to the ability to demonstrate it in small amounts by the route that was employed to inoculate the embryonated eggs. The differences between this test with the stock or typical strain of plague virus and the results reported heretofore appear accountable to the drift in pH and possibly the other factors associated with the use in the test of 10 per cent virus-infected allanto-amnionic fluid in the virus-buffer mixtures.

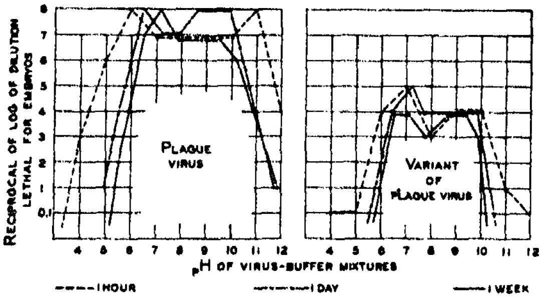

Fig. 2

These observations are believed to reveal a close relationship among four strains of Newcastle disease virus, a distinct diversity between the virus of Newcastle disease and that of fowl plague, and a similarity between the fowl plague virus and a variant virus derived from it. The pH-stability patterns of a representative strain of the virus of classical Newcastle disease and of strains of virus from cases of so-called pneumoencephalitis in California are believed to confirm the immunological evidences of the identity of the causal agents of these two diseases which possess divergent tropisms. Likewise, the patterns obtained for a classical strain of the virus of fowl plague confirmed information on its immunological identity with a variant virus of low virulence isolated from it. The results obtained with the fowl plague virus are in agreement with those recorded by Pyl. The stability patterns appear to be useful in the identification of the virus of Newcastle disease and of fowl plague.

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Effect of Gamma Globulin on Circulating Human Complement

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It has been shown by Davis, Kabat, Harris, and Moore (*1*) that the gamma globulin fraction of human serum separated by electrophoresis displays the same tendency to interfere with the activity of alexin as do globulin solutions prepared by other methods. These investigators noted that this effect was diminished or reversed by the addition of albumin and certain other serum proteins. However, since human gamma globulin is being used clinically for the prevention and modification of rubeola and infective hepatitis and has been under study as a therapeutic agent in scarlet fever, it appeared important to ascertain whether patients treated with this material exhibited any changes in the complement levels of their sera. This clinic has participated in a study of the therapy of scarlet fever with human gamma globulin, and the opportunity to study this question thus presented itself.

Methods

Normal gamma globulin was furnished by Sharp and Dohme. This fraction was prepared under the direction of E. J. Cohn and his associates in the Department of Physical Chemistry, Harvard Medical School, from pooled human plasma collected by the American Red Cross. Only lots containing 45 or more units of streptococcal antierythrogenic antibody/ml. were employed. In the course of other investigations with this material it was found to be anticomplementary in the test tube even after the addition of considerable amounts of human albumin (*2*). As stated previously, in the hands of Davis and his colleagues, human albumin decreased or abolished the inactivating effect of globulin on alexin. It is probable, therefore, that the preparation administered in this study was anticomplementary in high titer. Nine patients, whose weight exceeded 60 pounds, received intramuscular injections of 60 ml. of the globulin, while one child weighing 50 pounds was given 50 ml.

Blood was obtained prior to the administration of globulin and at 2-, 4-, 8-, 12-, 16-, 20-, 24-, 36-, and 48-hour intervals thereafter. In each case, one specimen was omitted, withdrawal of blood being avoided in the hours after midnight. However, the schedule was so arranged that no interval was consistently neglected. The sera were separated immediately after bleeding and promptly frozen. Complement titration was carried out with sheep erythrocytes and rabbit amboceptor, 2 units of amboceptor being added to 0.5 ml. of 5 per cent sheep erythrocytes. Determinations were made in saline containing .01, .02, .03, .04, .05, .06, .07, .08, .09, .10, .20, .30, .40, and .50 ml. of the serum being tested, respectively. All tubes contained a total volume of 2.5 ml. and were incubated for one hour at 37°C. before reading. On the basis of rather extensive experience with this method it has been found that the alexin titer (50 per cent hemolysis) of human serum is usually 0.03–0.04 ml. It has been shown repeatedly with this technique that in certain diseases the complement titer may be depressed to 0.10 ml. or more (*5*).

Results

The sera of the 10 patients examined before, and at frequent intervals for 48 hours after, the injection of normal gamma globulin all contained normal levels of complement; 0.04 ml. or less produced 50 per cent hemolysis regularly. Thus, no difference could be detected between control and postglobulin injection alexin titers.

Discussion

Because of its high antibody content (*2*), human gamma globulin is being used as a prophylactic and therapeutic agent in certain diseases (*4*). In light of the known complement-binding character of this material, the sera of patients injected with globulin were examined for alexin levels. No change was demonstrated. In view of the albumin content of human serum, the dilution by the circulating blood, and possibly the relatively slow rate of absorption following intramuscular injection, it is not surprising that gamma globulin, in the dosages usually employed, produced no demonstrable alteration in complement activity when administered intramuscularly to man. If preparations suitable for intravenous injection become available, the possibility that they may produce complement depression when administered by this route should merit investigation.

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[1] The authors are grateful for the cooperation of Drs. E. J. Cohn and J. L. Oncley, Department of Physical Chemistry, Harvard Medical School.

IN THE LABORATORY

False Disinfection Velocity Curves Produced By Quaternary Ammonium Compounds

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Quaternary ammonium compounds are being offered as disinfectants for the medical professions, as bactericides for the sanitization of eating utensils and drinking glasses, and as germicides for general use. The more widely used commercial bactericides of this class are Hyamine 1622 (p-diisobutyl-phenoxy-ethoxy-ethyl-dimethyl-benzyl ammonium chloride monohydrate) and the apparently identical or very similar Phemerol (p-tert-octyl-phenoxy-ethoxy-ethyl-dimethyl-benzyl ammonium chloride monohydrate); Roccal and the identical or closely related Zéphiran; Emulsept; Q.A.C.; and Teramine.

Before recommending to the State Department of Health that these compounds be approved as bactericides, additional studies of their efficiencies and limitations were made. When tested by the official Food and Drug Administration method for evaluating antiseptics and disinfectants (*3*), all appear to justify the very high "phenol coefficient" values of 250 to 625 against *Staph. aureus* (*1*) and approximately one-half as great against *E. typhosa* (*2*). The end points obtained when the F.D.A. method was used were very irregular, and plate counts of bacterial populations exposed to quaternary ammonium compounds revealed a very high initial velocity of disinfection:

$$K = \frac{1}{\text{time}} \cdot \log \frac{\text{initial number of organisms exposed}}{\text{survivors}}.$$

This was followed by a rapidly decreasing value of K. When the logarithms of the survivors, as determined by plate counts, were graphed against time, very steep curves were obtained for the first few minutes. The data presented in Fig. 1 are typical. In some instances, particularly when the bactericidal activity was tested in the presence of some additional organic material such as milk, the plate-count numbers again increased after several days and proteolytic decomposition of the milk took place.

Experimentally, it has been found that the presence of sterile evaporated milk allows the growth of organisms exposed to solutions of quaternary ammonium compounds, while parallel inoculations into broth fail to grow.

The shape of the death-rate curve may be somewhat influenced by the rapid removal of the quaternary ammonium compound from the solution. When used in the dilutions their phenol coefficient numbers would indicate them to be efficient bactericides, these compounds are rapidly removed from solution by particulate or organic materials. Also, the hypothesis is advanced that the very high phenol coefficient numbers previously reported for the quaternary ammonium compounds reflect the sum of the agglomeration of the organisms, and their bacteriostatic action in addition to their bactericidal action. These compounds are extremely surface-active cationic detergents, and the clumping of treated organisms, with their adhesion to glass surfaces, has been observed experimentally.

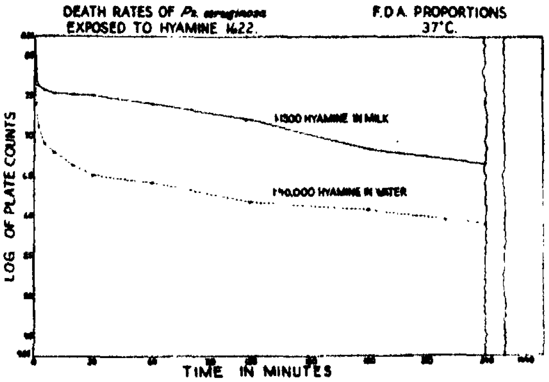

FIG. 1

In tests by the F.D.A. technic, the 1/100-ml. loop might not pick up a clump of agglomerated organisms which tend to adhere to the surface of the tube; if picked up, such a clump might remain adherent to the loop when it was immersed in the broth subculture; and if the coated and agglomerated organisms were placed in broth, in which no additional particulate material was present, they might remain in a state of bacteriostasis and fail to give rise to growth. In the case of plate counts in agar, many viable organisms in one clump would give rise to only one colony and hence would be read as only one viable inoculum.

Since it appears that the tendency of organisms to agglomerate and adhere to surfaces, following exposure to dilute solutions of the quaternary ammonium compounds, has influenced the end points obtained with the F.D.A. method and the apparent velocity of disinfection when plate counts were made, both the bactericidal efficiencies and the very favorable toxicity indices of these compounds must be re-evaluated.

In some clinical applications it is possible that a surface-active bacteriostat, of very low toxicity to tissues, may be more desirable than an active bactericide which decreases tissue vitality. Also, it has yet to be demonstrated whether viable organisms coated with quaternary ammonium compounds are infective or are readily destroyed by the natural defense mechanisms of the body.

The data thus far obtained indicate that, when employed in sufficient concentrations and in the absence of large amounts of particulate or organic materials, the quaternary ammonium compounds probably do disinfect.

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The Maillard Reaction in Microbiological Assay[1]

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In 1912 Maillard (*1*) pointed out that solutions containing amino acids and reducing sugars turn brown when heated. Although this browning reaction has recently been recognized to be of the greatest importance in nearly all industries concerned with materials of biological origin, including foods, it is still little understood because of its complexity. It occurred to the writers that further insight into the Maillard reaction might be gained through use of the microbiological assay technique, since the latter involves the autoclaving of solutions containing amino acids and dextrose (a reducing sugar) under conditions favorable to the Maillard reaction.

Accordingly, the customary casein hydrolysate medium was prepared for tryptophane assay with *Streptococcus faecalis* in such a way that the reducing sugar component of the medium (dextrose) could be autoclaved separately from the rest of the medium for comparison with a "normal" series, using medium containing identical ingredients but autoclaved in the presence of dextrose in the customary manner.

The growth curves obtained are shown in Fig. 1. Good growth was obtained by the standard procedure (Curve A), but still better growth was obtained in the medium prepared by autoclaving the dextrose separately from the rest of the medium and combining aseptically after cooling (Curve B). These results have been repeated and are reproducible.

It thus appears likely that optimal growth may seldom be reached in microbiological assays, due to the effects of the Maillard reaction. This would not be discovered in recovery tests, since both standard and unknown series would be autoclaved alike. The question arises, however, whether this apparent accuracy of the microbiological assay can always be relied upon, in view of the possibility that standard and unknown samples might differ in their ability to alter the influence of the Maillard reaction upon growth.

Since sucrose is not a reducing sugar and does not readily take part in the Maillard reaction, it was thought that sucrose might be preferable to dextrose, if satisfactory growth were obtained in a medium containing sucrose. Accordingly, a third series was prepared and run simultaneously with the assays shown in Fig. 1. In this C. P. sucrose replaced the dextrose ordinarily used but at one-half equimolar concentration (final concentration of sucrose in the medium, 1/12 M). Here again the growth obtained was better than "normal"; in fact, the growth curve obtained with sucrose in the medium was identical with Curve B (Fig. 1).

A certain amount of browning during autoclaving is commonly accepted as being inevitable in microbiological assay; however, our media using either sucrose autoclaved with the medium or dextrose autoclaved separately were *water white*. Compared with these, the normal medium transmitted 84.5 per cent as much light at 610 mμ, the decrease in transmission being due to the browning which occurred during autoclaving.

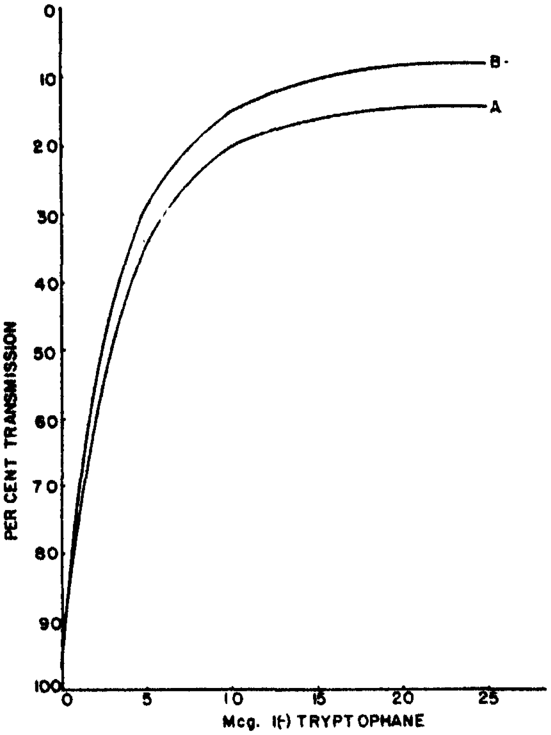

FIG. 1. Growth curves for tryptophane assay using *Str. faecalis*.

Whether the poorer growth obtained by the customary procedure is due to destruction of nutrients or production of growth inhibitors has not yet been determined. The Maillard reaction produces an increase in acidity, and the possibility that this may be responsible for the reduced growth has not been overlooked. The fact that the greatest differential in growth occurs at the higher growth levels lends support to this possibility. The actual difference in acidity due to browning was rather slight, however, amounting to a difference of only 0.96 ml. of 0.1 N acid in the uninoculated blank tubes, which was responsible for a difference in pH of only 0.2 (Curve A medium, pH 6.96; Curve B medium, pH 7.16).

The possibility that these results might be a peculiarity of the tryptophane assay, due to destruction of tryptophane during autoclaving, was ruled out by another series of assays. In these, graded levels of l-tryptophane solution were autoclaved *separately* before adding to the autoclaved media.

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[1] Published with the approval of the director of the Colorado Agricultural Experiment Station, as Scientific Journal Series No. 235.

Again, the same results were observed: the greater the extent of browning which occurred during autoclaving, the less the subsequent growth obtained with a given level of tryptophane.

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A Simple Method for Rearing Blowflies Without Meat[1]

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The methods used for rearing blowflies to be used in experiments on insect physiology or toxicology are reviewed by Woodbury (*2*). The disadvantages of these methods, in all of which meat or fish are used for larval food, are twofold: (1) Meat and fish are not always readily or cheaply obtainable, and (2) rotting of the flesh during larval feeding results in unpleasant odors.

Many expedients have been tried to minimize the escape of odors, but none of these is entirely satisfactory. Recently Hill, Bell, and Chadwick (*1*) have solved the problem by rearing blowflies on a sterile synthetic medium. While this method does eliminate most of the odors and allows control of the larval food, it involves the compounding and autoclaving of the medium. These procedures are time consuming and may even be impossible without technical assistance. Accordingly, a simple method for rearing blowflies in quantities, without using putrid meat, seemed desirable. *Phormia regina* Meigen was used in most of the tests, but other species of blowflies could undoubtedly be reared as well.

In the method developed the medium used for rearing larvae is ordinary commercial kibbled dog biscuit.[2] The bone-shaped biscuit can also be used but must be broken into small pieces.

Rearing containers are one- and two-quart Mason jars or gallon mayonnaise jars. In a jar, dog biscuit to a depth of about two or three inches is covered with water and allowed to stand for about two minutes. The water is then poured off, and eggs or young larvae of the blowflies are added. The jar is capped with a circle of fine-mesh wire cloth held in place by a ring cap. This allows air to enter freely and excess moisture to escape, while preventing the escape of the larvae. The larvae generally do considerable migrating, both in the mass of dog biscuit and on the walls of the jar.

When the larvae are nearly full grown, the jar is almost filled with coarse sawdust. In this, the larvae crawl about and pupate. The sawdust and pupae are then removed and the pupae sorted out for emergence, or the sawdust is left in the jar and the flies allowed to emerge there. Flies are removed from the jar by attraction to a light source.

Correct moisture content of the larval medium is an important consideration. This depends on the particle size: the smaller the particles, the less water needed for optimum moistness. Since different brands of dog biscuit and even different samples of the same brand vary considerably in particle size, the technique of moistening the material must be acquired by experience. If the medium is too moist, the larvae leave the food quite early and crawl about in the film of water on the inside of the bottle. In this case it is necessary to add a layer of sawdust, about one inch deep, over the dog biscuit. This usually takes up the moisture and drives the larvae back to the food.

If the dog biscuit is relatively coarse, the larvae will crawl about in it freely to a depth of three to four inches. If, on the other hand, the dog biscuit is fine, the larvae are restricted to the topmost layer and go only about one inch deep. Since their feeding ultimately causes the medium to pack, whatever its original consistency, the dog biscuit is utilized only to a depth of about two inches. Thus, increased production of flies cannot be obtained by increasing the depth, but only by using more jars or jars of larger diameter.

The production of large, well-formed flies is obviously dependent upon the density of larval population. Thirty to 40 grams of dog biscuit will produce 100 such flies. In a two-quart Mason jar we use about 250 grams of dry dog biscuit, and this produces up to 1,000 flies. Under these conditions, 100 flies are produced at a cost of about $.01, using dog biscuit purchased at a retail price of $.60–$.70 for 5 pounds. If purchased in bulk at wholesale rates, the cost would obviously be much lower.

Adult blowflies are kept in screen cages, where they are supplied with water, sugar, and moistened dog biscuit. The latter is both the oviposition medium and protein food necessary for oviposition. Since blowflies usually will not oviposit on freshly moistened dog biscuit, this material is allowed to remain moist a day or two prior to its use in the cages. If the atmosphere is dry, the dog biscuit is kept damp in the cages by placing it in a finger bowl lined with paper toweling on which a bottle of water is inverted.

Whether blowflies reared on meat will oviposit on moistened dog biscuit has not been determined. In earlier work, the eggs were collected on meat and transferred to dog biscuit for rearing only; thus, when the latter was tested for oviposition, it was tried with flies reared on it. Also tested for oviposition were nutrient agar and filter paper soaked in a strong nutrient broth kept moist by inverting a bottle of water on it. Blowflies fed on both of these but oviposited only on the filter paper. The number of eggs laid on the filter paper, however, was not great enough to warrant continuation of the tests.

This method for rearing blowflies makes possible the production of numbers of large flies with little apparatus and expense. Strangely, the moistened dog biscuit does not develop any objectionable odors while the larvae are feeding, the total lack of ammonia being particularly surprising. Odors that develop during the pupal period are held in the bottles by the sawdust. Thus, the rearing containers may be kept in an office or laboratory, no provisions being needed for air conditioning. Since no autoclaving or special preparation of media are needed, the method is very simple, and the relative constancy of composition of dog biscuit assures that the flies are physiologically quite uniform.

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[1] The technical assistance of Mr. Arnold Hultquist in testing this method is gratefully acknowledged.

[2] Brands used successfully in this laboratory are Milk Bone (National Biscuit Company), Daily (The Great Atlantic and Pacific Tea Company), and Kibbies (Morton's Dog Food Company, Minneapolis).

An American Bridge To World Science

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BOTH THE SCIENTIFIC AND THE GENeral press have been strangely neglectful of what is potentially a major opportunity to advance American science and, through it, to contribute to world peace. Indeed, there is considerable danger that, because of lack of action on the part of American scientific organizations, the opportunity may be sharply curtailed.

Senator J. William Fulbright introduced into the 79th Congress a bill to amend the Surplus Property Act of 1944. This bill, which was subsequently passed as Public Law 584, states in part:

> In addition to the authority conferred by section 15 of this Act, the Department of State may dispose of surplus property located outside the continental United States, Hawaii, Alaska (including the Aleutian Islands), Puerto Rico, and the Virgin Islands, for foreign currencies or credits, or substantial benefits or the discharge of claims resulting from the compromise, or settlement of such claims by any Government agency in accordance with the law, whenever the Secretary of State determines that it is in the interest of the United States to do so and upon such terms and conditions as he may deem proper. Any foreign currencies or credits acquired by the Department of State pursuant to this subsection shall be administered in accordance with procedures that may from time to time be established by the Secretary of the Treasury and, if and when reduced to United States currency, shall be covered into the Treasury as miscellaneous receipts.
>
> In carrying out the provisions of this section, the Secretary of State is hereby authorized to enter into an executive agreement or agreements with any foreign government for the use of currencies, or credits for currencies, of such government acquired as a result of such surplus property disposals, for the purpose of providing, by the formation of foundations or otherwise, for (A) financing studies, research, instruction, and other educational activities of or for American citizens in schools and institutions of higher learning located in such foreign country, or of the citizens of such foreign country in American schools and institutions of higher learning located outside the continental United States, Hawaii, Alaska (including the Aleutian Islands), Puerto Rico, and the Virgin Islands, including payment for transportation, tuition, maintenance, and other expenses incident to scholastic activities; or (B) furnishing transportation for citizens of such foreign country who desire to attend American schools and institutions of higher learning in the continental United States, Hawaii, Alaska (including the Aleutian Islands), Puerto Rico, and the Virgin Islands, and whose attendance will not deprive citizens of the United States of an opportunity to attend such schools and institutions: *Provided, however,* That no such agreement or agreements shall provide for the use of an aggregate amount of currencies, or credits for currencies, of any one country in excess of $20,000,000 or for the expenditure of the currencies, or credits for currencies, of any one foreign country in excess of $1,000,000 annually at the official rate of exchange for such currencies, unless otherwise authorized by Congress, nor shall any such agreement relate to any subject other than the use and expenditure of such currencies or credits for currencies for the purposes herein set forth: *Provided further,* That for the purpose of selecting students and educational institutions qualified to participate in this program, and to supervise the exchange program authorized herein, the President of the United States is hereby authorized to appoint a Board of Foreign Scholarships, consisting of ten members, who shall serve without compensation, composed of representatives of cultural, educational, student and war veterans groups, and including representatives of the United States Office of Education, the United States Veterans' Administration, State educational institutions, and privately endowed educational institutions: *And Provided further,* That in the selection of American citizens for study in foreign countries under this paragraph preference shall be given to applicants who shall have served in the military or naval forces of the United States during World War I or World War II, and due consideration shall be given to applicants from all geographical areas of the United States.

In other words, surplus tractors, jeeps, LST's, etc. remaining in Australia, Siam, Holland, and other countries may make possible cultural interchanges between those countries and the United States, much as the Boxer Indemnity Fund was used to provide fellowships in American universities for many young Chinese. How much money will be available under the bill is not yet clear, although present indications are that it may total several score of millions of dollars. Neither is it clear what proportion of the funds is to be available for science; this will depend, in part, on the interest and activity of scientists themselves.

If this opportunity is well handled, its value to science, and to American world relations through science, will be enormous. Eight years of work in foreign countries, in constant contact with scientists in many fields, have made three conclusions compellingly clear to me.

The first is that no channel for international communication offers such complete freedom of movement as scientific interchange. No matter what the tongue of the scientist, his mathematical, physical, or chemical formula says the same thing the world over. The biome, the life history of the bird, the analysis of social organization of wandering monkey tribes, may be approached through similar thought processes. The genetics of corn in Minsk, Córdoba, and Iowa City follows the same laws. The scientific worker, no matter what his discipline, finds a common bond with his co-worker on whatever side of the politician's "iron curtain." Furthermore, true internationalism, a feeling of mutual respect that transcends political limits, has existed for decades in the laboratories, libraries, and field stations. Houssay and Cannon, Shapley and Jeans, Leopold and Kashkorov, have never considered that a veto power might be necessary. Because of its international character, scientific aid is given and received freely and without thought of patronizing or being patronized; scientific aid is acceptable without question, and the giving of it is an accepted responsibility. Men have been united by science since the time of the Renaissance, and political internationalism can learn much from the scientific pattern.

However, despite the great debt of the United States to the science of the rest of the world, American scientists during the past two or three decades have shown a disturbing tendency toward parochialism. There are so many of us and we have become so content with living on our own fat that in many fields we have lost the stimulating beneficence of contact with scientists in other parts of the world. A distinguished European ornithologist once said to me: "The trouble with American mails is that they move in only one direction—outward." In part because we have been too lazy to command foreign languages, thousands of us have little knowledge of important research that is being carried on abroad; a very general ignorance of Spanish and Portuguese cuts us off from investigations in Europe, Mexico, Uruguay, Argentina, and Brazil. Even were we better prepared in the use of languages, we should still need closer contact with co-workers about the world. Were it possible for more of us to work in foreign laboratories and field stations, to hammer out our ideas on other people's anvils, to sit down face to face with our scientific fellows, and, above all, to understand the opportunities and limitations of the environment in which our colleagues are working, it would give our own science a revivifying injection of adrenalin. To know, for example, that one of the world's most productive ecologists has less than $200 a year, apart from his own small salary, for all field and laboratory expenses should give an encouraging lift to any college professor trying to maintain his research program in the face of expenses that are mounting as rapidly as GI enrollments. To learn that the total budget of the Bureau of Animal Husbandry in an eastern European country is less than $400 a year should help our thinking about the problems of Greece, Turkey, and their neighbors. We are likely to identify other parts of the earth with the United States and try to make geography fit our premises rather than our premises fit geography! In foreign countries I have often seen American technologists feeling thoroughly abused because the entire complex in which they were working was so different from Kansas or Iowa; in Korzybski's useful phrase, their maps do not fit the territory in which they must operate.

In many fields, foreign experience would widen and deepen our own research potentialities. Our zoologists and botanists need to know the tropics. "To such students," writes Harold J. Coolidge, executive secretary of the Pacific Science Board (*Science*, January 31), in a personal letter to Senator Fulbright, "the possibility of working on ecological problems in New Guinea or zoogeography where Wallace did his field work represents nothing more than a naturalist's dream, far from any hope of realization." Our museums have great gaps in their collections. Our anthropologists can enormously lengthen their horizons by work around the fringes of the Pacific. As our scientists further develop the sense of political responsibility they have begun to show, and play an increasingly influential part in the shaping of America's national and international policies (which, we are beginning to realize, are inseparable), they will be far more valuable citizens for their understanding of foreign environments—in the broad sense that includes physical as well as intellectual and other cultural factors.

Finally, the American scientist abroad is one of the world's most useful citizens. Despite our many shortcomings, we have much that many other countries need. In dozens of nations, even university curricula do not include the teaching of basic sciences. In man's struggle to survive in environments that are rarely as favorable as those of the United States, the dice are loaded against him because of the lack of scientific information. On millions of overpopulated square miles living standards are dropping, often at accelerating rates, in large part because of man's failure to understand and abide by biophysical laws. A concrete example is the complete dependence of some 80,000,000 people in Latin America on wood for cooking, heating, and many industrial purposes. Yet there is not a Latin-American country that maintains a sustained-yield forestry program; nowhere in an area twice the size of the United States, with nearly as large a population, is there such a forest products laboratory as we have at Madison, Wisconsin. Scores of millions of acres of topsoil have been lost through cut-and-get-out forest exploitation methods; hundreds of people have been drowned by floods caused primarily by deforestation; silt from deforested slopes is ruining desperately needed agricultural land in a great area where less than 10, and perhaps not over 5, per cent of the land surface is suitable for agriculture. And not more than two Latin-American countries possess good forestry schools!

Diseases killing thousands of people a year are so little understood that not even the taxonomy of their insect vectors is known. Countries whose normal nutritional level (1947) is below that of German prison camps know nothing of their climatology, soils, and hydrologic regime, or such ABC's of the land manager as plant associations, successions, etc.; nor has their nutrition been more than approximately studied. Not only do we not have information as to what species of plants and animals are threatened with extermination, in the case of threatened species we do not know enough of their biology to set up a restoration program. Mapping, basic to so much scientific research, is retarded in most of the world; one country recently discovered, by courtesy of the AAF, that, instead of having an area of 13,000 square miles, it possesses only a little over 8,000! The mere knowledge of indicator species of plants, were it available today, would *literally* be worth tens, and quite possibly hundreds, of millions of dollars to the single nation of Venezuela, which is confronted with one of the most difficult conservation problems now in existence. I have specifically mentioned Latin America because of firsthand acquaintance with a number of its countries; similar situations obtain, however, in most other parts of the world. The vast lacunae in land-use sciences also have counterparts in many other fields.

That the support of such scientific work was the intention of the author of the Fulbright Bill is made clear by further excerpts from the letter of Mr. Coolidge, quoted above, and Senator Fulbright's reply. Mr. Coolidge writes in part:

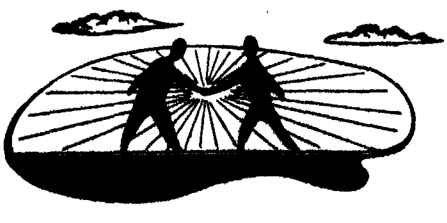
> I feel that there are two important kinds of help required to enable the qualified student to engage in field research. First, the assurance of a friendly reception and extension of certain facilities by the government of the foreign country concerned. This is a matter that can usually be arranged with the assistance of the State Department, and should not present great difficulties for Americans in most countries in the postwar world. Secondly, the highly difficult problem of finding funds to finance travel and field or laboratory research in the foreign country where the research is to be undertaken.
>
> The Fulbright Bill makes it possible through the Board of Foreign Scholarships, with the assistance of the State Department, to solve this serious problem in a way that should not only greatly benefit the student, as well as the foreign country involved, but should likewise assure the possibility of great strides in the advancement of fundamental scientific knowledge and the training of competent men, particularly in the fields of the natural and related social sciences. . . .
>
> I sincerely hope that provisions will be made to insure the participation of well-known scientists on your Board of Foreign Scholarships.

To this letter Senator Fulbright replied:

> I wish to acknowledge your very thoughtful letter of March 10. I am in accord with your views about the possibilities of the bill which I introduced.

The export of American science to other parts of the world, and the benefit to the United States through scientists participating in this export, such as would be possible under the Fulbright Bill, would probably contribute as much to a stable, peaceful world as could any human activity.

What the people of the United States get from their government depends largely on what they ask for. Despite the considerable sums we may hope for under the Fulbright Bill, these funds are, of course, limited. Many interests will be competing for them. Unless science speaks clearly, vigorously, and soon, it is not likely to participate to any considerable extent. It is to be hoped that the scientists from the United States will see the opportunity presented to them under this bill and insist, through their organizations, that science be given its full share.



A New Class of Antifilarial Compounds[1]

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THE OCCURRENCE OF FILARIASIS IN members of the Armed Forces stationed in South Pacific areas led to organization by the National Research Council, in 1944, of coordinated investigations of the chemotherapy of this disease. The potency and the margin of safety of organometallic compounds, now used in the treatment of filariasis, may be improved by continued research; however, it was decided to concentrate the effort of this laboratory on compounds containing no heavy metal, in the hope of disclosing a new approach to the chemotherapy of this disease.

Unfortunately for chemotherapeutic research, the human form of the parasite, transmitted by various mosquito vectors, has not been found in other animal species, and it was necessary to restrict the study of new compounds to animals infested with closely related, but not identical, filarial parasites. For this purpose the most practical approach to the problem was afforded by the use of the wild cotton rat, which frequently harbors *Litomosoides carinii*, a filarial worm that resides in the pleural cavity rather than in the lymphatic system (*1*).

Although the details of the techniques employed in "screening" compounds *in vivo* for possible antifilarial activity underwent many modifications as the studies progressed, all procedures were based on the principle that each compound should be given in an amount approaching that maximally tolerated by the animal host. Further, it was considered that the frequency of dosage should be such as to favor the maintenance of a concentration of drug in the tissue fluids bathing the parasite. It was believed that these precautions might increase the possibility of detecting minimal activity in a compound, as a lead for further study.

In general, compounds were administered intraperitoneally at maximally tolerated doses every 8 hours for a total of 18 doses. Forty hours after the final injection, autopsy was performed, and the adult filariae were removed aseptically from the pleural cavities and placed in a sterile nutrient medium for observation; worms removed from an untreated rat were observed simultaneously. Characteristically, unaffected worms remained motile for at least two days, when observed at room temperature. When motility was absent and did not appear within about 8 hours after the worms were removed from the rats, the filariae were considered dead, and other criteria of death supported the validity of this simple measurement.

The effect of drug treatment on microfilariae, either *in vitro* or *in vivo*, was not studied, since it was known that the susceptibility of the embryos may differ from that of the parent worms, and it was the latter only toward which therapy was directed. Also, it was felt that "screening" of unrelated chemical substances for filaricidal activity *in vitro* would give information more likely to be misleading than helpful. Later, when a lead was obtained from studies *in vivo*, and more had been learned concerning the metabolism of these filariae, studies *in vitro* became of great importance.

Among the many compounds studied, none was found to possess appreciable activity until a member of the group of compounds known as the cyanine dyes was tested. This compound, (1-amyl-2,5-dimethyl-3-pyrrole) (1,6-dimethyl-2-quinoline) dimethinecyanine chloride (Chemotherapy Center #348), was completely curative in the maximally tolerated doses used. On further study it became evident that a very high degree of activity was present, since the intraperitoneal injection of 0.1 mg./kg. at 8-hour intervals for 18 doses regularly killed all filarial worms in all the treated animals. Fortunately for the chemotherapeutic program, the high activity of #348 was found to be shared by many others of a large group of compounds synthesized by L. G. S. Brooker and his associates, of the Eastman Kodak Company and supplied to the Committee on Medical Research of the National Research Council through Parke, Davis & Company.[2]

The cyanines were also strikingly active *in vitro*, not only in causing a rapid disappearance of motility but also in inhibiting the consumption of oxygen by adult filariae.

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[1] The work described in this paper was done, in part, under a contract recommended by the Committee on Medical Research, between the Office of Scientific Research and Development and Western Reserve University (August 1, 1944-October 31, 1945); in part, under a contract between the Office of the Surgeon General, U. S. Army (November 1, 1945-December 31, 1946); and in part, with the aid of a grant from the U. S. Public Health Service (since January 1, 1947).

[2] From the beginning of the study of this group of compounds, we have enjoyed the finest cooperation from Dr. Brooker and from Parke, Davis Laboratories. Further, this investigation has been facilitated in innumerable ways by Lucille Farquhar, technical aide of the National Research Council, who coordinated studies in this and related fields. Other members of this series of compounds have been studied by R. N. Bieter, H. N. Wright, and their associates at the University of Minnesota.

The oxidative metabolism of the worms was inhibited by concentrations of #348 ranging from 1:25,000,000 to 1:6,000,000, and the decrease in oxygen consumption was associated with a compensatory increase in aerobic glycolysis and a decrease in glycogen synthesis. Under anaerobic conditions no effect on glycolysis was observed. Only with concentrations 1,000–2,000 times higher was the oxygen consumption of mammalian tissue slices or homogenates affected by these compounds, and such concentrations caused severe injury at the site of subcutaneous or intramuscular injection.

For the following reasons it is postulated that these drugs exert their chemotherapeutic effect through inhibiting one or more enzyme systems concerned with oxidative metabolism: (1) Worms removed from rats treated with subcurative doses of active members of the cyanine series showed markedly depressed respiratory activity and an increase in aerobic glycolysis; (2) of the large series studied, every compound active *in vivo* inhibited filarial respiration *in vitro*.

As the study of the cyanines progressed, it became evident that activity in inhibiting filarial respiration *in vitro* could be retained despite rather radical variations in structure. Almost all cyanines (and many styryl) dyes show the effect to some extent, although the activity is by no means always of a high order. The grouping characteristic of the cyanine (and styryl) dyes, whether highly or weakly active, is the amidinium-ion system in which a positively charged quaternary nitrogen is linked

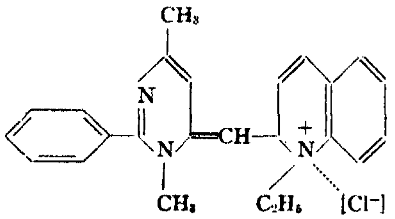
$$>\overset{+}{N}=\overset{|}{C}-(\overset{|}{C}=\overset{|}{C})_n-N< \;\leftrightarrow\; >N-\overset{|}{C}=(\overset{|}{C}-\overset{|}{C})_n=\overset{+}{N}<$$

to a tertiary nitrogen by a conjugated chain consisting of an uneven number of members. One or both of the nitrogens may be part of a heterocyclic ring, but activity is not restricted to any particular ring. Any modification which destroys the possibility of amidinium-ion resonance in the compounds causes a disappearance of high activity both *in vitro* and *in vivo*.

Variations in the manner of administration of active members of the series indicated that the drugs were effective when given intravenously, as well as intraperitoneally, but only occasional cures followed massive oral dosage. Cures followed subcutaneous administration of the drugs only when doses equal or close to those maximally tolerated by this route were used. Furthermore, subcutaneous or intramuscular injection caused damage to the tissues which, with certain members of the series, was very severe. The effectiveness of intraperitoneal administration once daily was slightly greater than that following administration every 8 hours; thus, with #348, a total of 1.8 mg./kg. was required when administration was at 8-hour intervals for 6 days, while a total of 1 mg./kg. was curative when the drug was given once daily for 5 days. Actually, cures could be obtained when animals were given a single dose of 1.35 mg./kg.

Since the intravenous route of administration of the drugs appeared to be the only feasible one for man, study of the activity of various members of the series was made in cotton rats, using this mode of administration. Attention was also given to the comparative damaging effects on tissues, in view of the possibility of extravasation.

One member of the series was clearly outstanding; this compound, Chemotherapy Center #863, is probably of the following structure, a name for which is 1′-ethyl-3,6-dimethyl-2-phenyl-4-pyrimido-2′-cyanine chloride, although an isomeric structure is possible.



In infested cotton rats, cures were almost invariably produced when #863 was given intravenously in doses of 1.0 mg./kg., repeated 3–6 times at intervals of 1, 3, or even 7 days. This indicates clearly, as did the earlier intraperitoneal studies with #348, that curative results can be correlated rather closely with the total amount of drug administered over a wide range of dosage intervals. This situation resembles that observed with certain organometallic drugs, e.g. as used in the treatment of syphilis. Toxic effects, according to the dosage schedules described, were seen only with individual doses of 10 mg. or more/kg. Accordingly, this route of administration appeared to offer a considerable margin of safety.

Extensive studies of the chronic toxicity of #863 in dogs and in monkeys have been based on the findings in cotton rats. These studies disclosed a mild and reversible renal damage as the only manifestation of chronic toxicity.[3] During intravenous administration there is a transient hypotensive effect, with compensatory tachycardia; this effect is of consequence only when large doses are rapidly administered.

A method for the extraction of #863 from tissues and its spectrophotometric determination at 494 mμ has been devised. The compound rapidly disappeared from the blood of dogs after intravenous administration, but urinary excretion rarely exceeded 5 per cent. Recovery experiments indicated that the drug is metabolically altered. The material is remarkably concentrated in the kidney; when dried from the frozen state, the drug was visible microscopically, predominantly in the convoluted tubules.[4] This finding may account for the observed renal toxicity.

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[3] We are indebted to W. B. Wartman for his cooperation in the pathological examination of the tissues of animals subjected to treatment with #863.

[4] These observations were made by Normand L. Hoerr and Arnold Lazarow, to whom our thanks are due.

Studies of the possible effectiveness of #863 in the treatment of human patients infested with the filariae of *Wuchereria bancrofti* have been initiated through the facilities afforded us by the School of Tropical Medicine, San Juan, Puerto Rico.[5] The drug was administered to 27 patients, using various intravenous dosage regimes, without manifestations of systemic toxicity other than transient mild hypotension and tachycardia of no clinical significance. Since the drug usually does not cause an immediate disappearance of microfilariae, in either cotton rats or man, studies of the peripheral blood may be required for many months in order to determine whether sterilization or death of the parent worms has been accomplished.

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[5] We are greatly indebted to the director, P. Morales-Otero, for many courtesies; to José Oliver-González, who procured the patients and gave us constant help; and to F. Hernández-Morales, D. Santiago-Stevenson, and Ramón Suárez, Jr., for their clinical aid and excellent cooperation.

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Nomenclature of Parenteral Proteases

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RECENT INTEREST IN CERTAIN PROteases, which participate in blood coagulation (*5*, *21*) and indirectly related proteolytic phenomena, e.g. fibrinolysis (*3*, *16*, *19*), has run into a confusion of nomenclature which should be settled by general agreement. The story of the *parenteral* proteases and fibrinolytic phenomena was fully reviewed in the monumental work of Oppenheimer (*18*), whose classificatory principles have been widely accepted, with some more modern modifications.

PROTEASE, in the broadest sense, refers to all enzymes associated with protein hydrolysis. PROTEINASE is a general term appropriately used when the substrate is the whole protein molecule. Owing to multiplicity of substrates, enzymes acting under this head must be subclassified, empirically, under such generic terms as (1) *peptases*, (2) *cathepsins* (which has largely replaced the older term, ereptases), and (3) *tryptases*, for the three most common types of animal origin; and (4) *papainases*, for an important group of plant proteinases. It is distinctly intended that these terms group together enzymes on the basis of certain similarities, in the case of the first three, to the well-known alimentary prototypes, pepsin, erepsin, and trypsin(s), *disregarding* differences in origin and certain other differences, e.g. in mode of activation, inhibition, substrate specificity, stability, purity, etc. Even pH optima are currently minimized, as chiefly a matter of protein stability and purity. The recent identification of certain proteinases as crystalline proteins (*17*) and the newest means of testing on pure synthetic polypeptide substrates (*1*) are steps toward characterization of a few of these enzymes by their chemical specificity, in terms, for example, of certain linkages in the substrate molecule. The crystalline enzymes thus studied, however, show multiple points of attack on the protein (polypeptide) molecule. Hence, this approach is more successful as a basis for identification of the *individual* enzymes than as a means of classification (cf. *1*).

The Nobel-laureate work of the Rockefeller investigators (*17*), significantly extending the pioneering efforts of Willstätter and others, clearly outlines the general principle that each proteolytic enzyme really constitutes a *complex system*. This is especially well exemplified in the case of pancreatic trypsin: An inactive precursor or zymogen (TRYPSINOGEN, crystalline) is converted into active enzyme (TRYPSIN, crystalline), particularly through the mediation of an "activator," e.g. ENTEROKINASE (*17*), MOLD KINASE (*11*), etc.[1] A crystalline polypeptide (TRYPSIN INHIBITOR, *pancreatic*) inactivates fully-formed trypsin by formation of a crystalline inactive TRYPSIN + INHIBITOR compound (*17*). A recently crystallized protein TRYPSIN INHIBITOR from *soybean* (*12*) probably acts in the same way. Since there is multiplicity both of inhibitors and of the proteases they inhibit (e.g. chymotrypsin and plasma-tryptase, also), the nomenclature, ANTITRYPSIN, should be used with these reservations. The possibility of KINASE inhibitors, directed against the "activators" rather than against the protease proper, is not fully explored in the work on the pancreatic enzymes.

The "thromboplastic-enzyme" theory of blood coagulation (*5*) draws attention to similarities between the experimental actions of pancreatic trypsin and natural TRYPTASE enzymes demonstrable in, but not yet isolated from, plasma (serum), blood corpuscles (including platelets), and tissue source materials. Very recent work (*6*) is completely confirmatory of this idea and suggests adoption of the following nomenclature, in close analogy with the pancreatic tryptase system:

I. TRYPTASE: active protease, prefixed by name of source material, e.g. *serum*-tryptase, *brain tissue*-tryptase, etc.

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[1] Crystalline trypsin assists its own formation from crystalline trypsinogen in an autocatalytic manner, and certain factors, e.g. CALCIUM, are important accessories because they prevent loss of enzyme through side reactions of an inactivating nature (*14*).

II. Tryptogen: inactive precursor on the enzyme, similarly prefixed.

III. Tryptokinase: general term for "activators" of tryptogen, including *streptococcal* TRYPTOKINASE or STREPTOKINASE ("streptococcal fibrinolysin" is criticized below) and suspected *physiological* tryptokinase factor(s) (*9*).

IV. Antitryptases: tryptase inhibitors (see above), including proved (*6*) actions of the (crystalline) trypsin inhibitors of *pancreatic* (*17*), *soybean* (*12*), and *egg-white* (*6*) origin, *serum*-antitryptase (as yet unidentified), etc. (*10*).

V. Antitryptokinases: inhibiting the tryptokinase "activator," including the clearly demonstrated antibody detected in blood after streptococcal infections ("streptococcal antifibrinolysin," *10*).

Tryptase merely means trypsin-*like*, in many experimental situations (*5*). Other suggested terms are criticized as follows: The time-honored term, "FIBRINOLYSIN" (*3, 16, 19*), most recently revived by Loomis, *et al.* (*13*), must be discarded because (1) it suggests a specificity for *fibrin* substrate which is quite unfounded according to data going back to the earliest investigations; and (2) much confusion carries over from the erstwhile failure to distinguish enzyme and its activator(s), e.g. "streptococcal *fibrinolysin*" (*8*) (now recognized as a misnomer, *2*). "Fibrinolytic protease," as a descriptive noncommittal term, is acceptable (*10*). "Plasmin" is the latest suggestion (*2*) but is objectionable because (1) it indicates a *plasma* origin and ignores similar protease(s) from tissue (cellular) sources; (2) the plasma presumably gets it from some cellular source in the first place; (3) pending isolation and identification, a specific name is premature; (4) Christensen dismisses, perhaps too lightly, the all-but-forgotten use of the term (Fr. *plasmine*) for a crude salt-precipitated mixture of plasma proteins, by Denis (*4*), which retains historical interest both in connection with coagulation (fibrinogen) and as the first step toward the modern general method of isolation of proteins by fractional precipitation.

Tryptogen (*5*) is preferred to "PLASMINOGEN" for the same reasons. Names like "LYTIC FACTOR" (*15*) are merely preliminary to the establishment of the definite idea. "Profibrinolysin" (*13*) must be ruled out because "fibrinolysin" is inacceptable.

Streptokinase (*2*) is quite acceptable for the streptococcal "activator," especially when it is recognized as one member of a group (hence, *streptococcal*-TRYPTOKINASE) which merits the general term, TRYPTOKINASE.

Antitryptase(s), again, is a good group name, conveniently used in lieu of TRYPTASE INHIBITOR, and the inclusion of known ANTITRYPSINS (TRYPSIN INHIBITORS) is as interesting as a priori considerations would lead us to anticipate. "Antifibrinolysin" (*13*), following long usage (cf. fibrinolysin), would mean antienzyme, but suffers in light of the criticisms against calling the protease by this term. The use of "ANTIFIBRINOLYSIN" (*10*) for the immunological inhibitor of the *kinase* obviously causes confusion. "Antiprofibrinolysin" is not much better, since it is also involved in the ambiguity of "fibrinolysin." Antitryptokinase, therefore, is logically preferred, with ANTISTREPTOKINASE admissible as a special case. Notwithstanding noteworthy differences in origin (*22*), kinase activators (*10*), and exact modes of proteolytic action (*2, 7*), the very striking similarities of natural plasma tryptase to pancreatic trypsin in general proteolytic effects and, particularly, in relation to blood clotting, fully justify the suggested group nomenclature. This classificatory terminology, moreover, has permanent value, even when the individual members of the class become separately characterized on the basis of biochemical character and substrate specificities.

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It is proposed to hold an informal meeting at the Stevens Hotel, Chicago, on the evening of Sunday, May 18, on the occasion of the annual meetings of the Federation of American Biological Sciences, at which this topic may be discussed by interested workers. The author would welcome the names of those who wish to attend and the comments of others, unable to be present, who would like their views to be presented at this meeting.

The present publication is part of a project on "Enzymes and enzyme inhibitors in relation to blood coagulation and hemorrhagic disorders," aided by a grant from the John and Mary R. Markle Foundation.

Obituary

William Perry Hay

1871–1947

William Perry Hay, naturalist and educator, died at his home in Bradenton, Florida, on January 26, 1947, at the age of 76. He was born at Eureka, Illinois, on December 8, 1871; was graduated from Butler University, Indianapolis, in 1891; began his teaching as head of the Department of Biology in the Washington, D. C., high schools in 1892; and taught in a number of schools and colleges in and about Washington until the time of his retirement in 1934.

He grew up in a home of biological tradition, his father, Oliver P. Hay, of the U. S. National Museum, being one of the foremost students of both living and fossil reptiles. The son, though mainly busied with teaching, was also a herpetologist in his own right. Retirement brought him leisure, which he employed to the end of his working days in the study of his favorite groups, the snakes and salamanders. He had prepared the many detailed and accurate drawings needed for a comprehensive work on North American herpetology and had almost completed the text at the time of his death.

Before retirement from teaching Prof. Hay lived at Kensington, Maryland, and was an active participant in the work of a number of Washington scientific societies. He was a founder of the Washington Biologists' Field Club, and when that club was incorporated in 1901, he was elected president. He was a chief promoter of one of the Club's most unique and important enterprises: the establishment of field headquarters and the erection of a building for it on Plummer's Island in the Potomac River. This bit of earth has since become, with respect to its resident fauna and flora, one of the best-known spots in the whole world.

During World War II be had a large share in directing the useful service of the Hegener Research Supply of Sarasota. When the chief medical laboratories of the Nation were calling for the tropical animals needed in their research work, Prof. Hay offered his zoological knowledge and practical laboratory experience in order to aid in supplying the necessary animals. For this work he was awarded a Certificate of Merit by the Office of Scientific Research and Development, on recommendation of its Committee on Medical Research.

Twice in his time Prof. Hay accumulated a considerble zoological library. On retirement from teaching he gave the greater part of his books to the library of the U. S. National Museum. While in Florida he again gathered together books of great value for the use of college students, and these he gave to the Department of Zoology of the University of Florida, Gainesville. He was ever a friend of youth.

JAMES G. NEEDHAM

Lake Placid, Florida

Harris Perley-Gould

1871–1946

Harris Perley Gould, former head of the Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry, Soils and Agricultural Engineering, U. S. Department of Agriculture, died October 17, 1946, in Washington, D. C.

Mr. Gould was born at North Bridgton, Maine, September 6, 1871, the son of Charles Henry and Bertha S. (Wadsworth) Gould. He was graduated from the University of Maine with the B.S. degree in 1893 and received the M.S.A. degree at Cornell University in 1897. From 1899 to 1901 he served as assistant entomologist and horticulturist at the Maryland Agricultural Experiment Station. His early horticultural research resulted in several publications at each of these institutions.

Upon organization of the Bureau of Plant Industry in 1901 Mr. Gould joined the staff as assistant pomologist and was actively engaged in horticultural research and administration until his retirement in 1941, after three years as head of the division that includes all Federal horticultural investigations. He was an outstanding authority on fruit varieties and conducted extensive regional studies on their adaptation to climatic and physiographic conditions, particularly in southern and eastern fruit-growing sections. The results of his studies are included in 15 Farmers' Bulletins and some 25 technical and popular articles on horticultural subjects. He was also the author of a book entitled *Peach growing*, in the Rural Science Series. As collaborator, he continued his active interest in pomology after his retirement. The habits of industry acquired on a New England farm became a part of his character. To all horticulturists, professional and practical, he gave generously of his time and effort, and his interest in them and in the science and art of fruit production was untiring.

GEORGE M. DARROW

Plant Industry Station,
U. S. Department of Agriculture, Beltsville, Maryland

NEWS
and Notes

Brookhaven National Laboratory, now under construction on the 6,000-acre site of Camp Upton, Long Island, New York, is a government-owned, government-financed atomic research project operated by Associated Universities, Inc., under contract with the U. S. Atomic Energy Commission. The Laboratory's program will be oriented toward the development of fundamental scientific information on the nature and properties of atomic energy, its application to chemistry, physics, medicine, and biology, and improved techniques for the production of atomic power and the preparation of radioactive isotopes.

Results of studies carried on will be unclassified.

Facilities will include a graphite uranium pile, a "hot" laboratory for the purpose of separating radioactive isotopes, still another pile with 100 times the neutron flux of the first, a 30,000,000- to 40,000,000-electron volt cyclotron, a 600,000,000- to 1,000,000,000-electron volt synchrocyclotron, an electronuclear machine in which electrons or positive particles may be accelerated to energies of 1,000,000,000 volts, and various other forms of apparatus beyond the reach of individual institutions. Prior to completion of the larger equipment the staff will experiment with cosmic rays and induce radioactive substances such as C^{14}.

Ultimately, a permanent staff of 300 scientists will be assigned to the Laboratory. In addition, there will be a visiting staff of about 200 and administrative, technical, maintenance, and service personnel totaling about 2,000. It is expected that about 100 scientists will have been assigned by the fall of 1947.

Associated Universities, Inc., is a nonprofit corporation formed by 9 major eastern universities, each of which nominates two trustees. The universities and their representatives follow: Columbia University—I. I. Rabi and George B. Pegram; Cornell University—F. A. Long and A. S. Adams; Harvard University—G. B. Kistiakowsky and Edward Reynolds; Johns Hopkins University—R. D. Fowler and P. S. Macaulay; Massachusetts Institute of Technology—J. R. Zacharias and J. R. Killian, Jr.; University of Pennsylvania—L. N. Ridenour and W. H. DuBarry; Princeton University—H. D. Smyth and G. A. Brakeley; University of Rochester—George B. Collins and R. L. Thompson; Yale University—W. W. Watson and E. W. Sinnott; Between full meetings of the Board of Trustees an Executive Committee (see cover) acts with authority in determination of Laboratory policies. Eldon C. Shoup, full-time executive vice-president of AUI, is responsible for executing the policies and programs of the Board. The director of the Laboratory, Philip M. Morse, is assisted by a Scientific Advisory Committee, the membership of which is composed of the 9 scientists on the Board of Trustees. Assistant director of the Laboratory is Robert A. Patterson.

The activities of the Laboratory are to be organized departmentally around fundamental fields of research. The Physics Department, which has already begun its work, is headed by N. F. Ramsey. Also under way are the Electronuclear Machines Project, under M. Stanley Livingston, and the First Pile Project, headed by Lyle B. Borst.

In the words of the director, "By our research in physics and chemistry, we hope to learn more about the behavior of atoms so as to control atomic energy for beneficial uses. In biology and medicine, we will learn more about living organisms, in order to develop methods of treatment for diseases such as cancer and many other ills. By fundamental research in engineering, we hope to be able to speed the development of atomic power production."

The Executive Committee of the Inter-Society Committee for a National Science Foundation has endorsed S. 526 (the Smith Bill) with two suggested amendments. First is that the number of members of the Foundation be reduced from 24 to 9. Second is the recommendation that the Director be appointed by the President, after consulting with the members of the Foundation, by and with the advice and consent of the Senate. These recommendations were made on May 1 in letters to Senator Taft, chairman of the Senate Committee on Labor and Public Welfare, Senator Smith, principal author of the bill, and Representative Wolverton, chairman of the House of Representatives Committee on Interstate and Foreign Commerce. That Committee is considering science foundation bills in the House of Representatives.

The Executive Committee met in Washington, D. C., April 28. The meeting was attended by Edmund E. Day, Ralph W. Gerard, Harlow Shapley, C. G. Suits, Homer W. Smith, Douglas Whitaker, and Dael Wolfle.

About People

Carl C. Lindegren, research professor of botany, Washington University, St. Louis, spent the month of April at the University of Washington, Seattle, as a Walker Ames professor of botany. His series of lectures will be published in the near future under the title *Yeast genetics*.

Fernandus Payne, dean of the Graduate School, Indiana University, addressed the Sigma Xi Club of the University of Louisville April 18 on "The Cytology of the Pituitary Gland of the Fowl."

Peter R. Morrison, Department of Physical Chemistry, Harvard Medical School, has been appointed assistant professor of zoology and physiology at the University of Wisconsin, beginning in September.

Theodore L. Swenson, special assistant to the chief of the Bureau of Agricultural and Industrial Chemistry, Department of Agriculture, has been appointed head of the food technology section of the Stanford Research Institute, where he will coordinate scientific research with developments in the food-processing industry.

H. H. Mottern, food research chemist, has been appointed director of research of the H. J. Heinz Company, where he has been a member of the research staff since 1945. Previously Dr. Mottern was with the U. S. Department of Agriculture.

Donald F. Jones, geneticist at the Connecticut Agricultural Experiment Station, will address the members of the Plant Institute, Ohio State University, May 19, on "Our Concepts of Hybrid Vigor Today and Yesterday." At a dinner to be held in his honor, Dr. Jones will speak on "The Development of Hybrid Seed Corn in the United States."

John A. C. Bowles, associate director, Research and Control Department, Rexall Drug Company, has been appointed director of the newly-created Product Development Laboratory, Medical Research Division, Sharp & Dohme, Inc.

Grants and Awards

Selman A. Waksman will receive the 1947 Passano Foundation Award of $5,000 at a presentation dinner scheduled for June 12, during the week of the meetings of the American Medical Association in Atlantic City. In addition to Dr. Waksman's address, "Antibiotics and Tuberculosis—A Microbiological Approach," the program will include a brief address by Sir Howard Florey, Oxford, England, who was knighted for his development of the clinical applications of penicillin.

Dr. Waksman receives the award for his original research in the field of antibiotics culminating with his discovery of streptomycin. The Passano Foundation, established in 1943 by The Williams & Wilkins Company, medical publishers, Baltimore, Maryland, provides the award to encourage medical research, especially that which has clinical application.

Clyde E. Keeler, a member of the faculty, Georgia State College for Women, Milledgeville, received the prize offered for the first time by the Association of Southeastern Biologists for the best research paper presented at its annual meeting. Dr. Keeler's prize-winning report was entitled: "Modification of Brain and Endocrine Glands as an Explanation of Altered Behavior Trends in Coat-Character Mutant Strains of the Norway Rat."

The 1947 Edward L. Bernays Atomic Energy Award of a $1,000 U. S. Government bond will be made by the Society for the Psychological Study of Social Issues to the individual or group contributing the best action-related research in the field of the social implications of atomic energy, according to an announcement by David Krech, chairman of the Award Committee. All research published or completed in 1947 or manuscripts reporting such research but not yet published are eligible for consideration. Reports must be submitted in duplicate not later than November 1, 1947. All communications relative to the Award should be addressed to Dr. David Krech, Swarthmore College, Swarthmore, Pennsylvania.

Colleges and Universities

Stanford University has announced the following promotions: Hubert S. Loring and Richard A. Ogg, Jr., professors of chemistry; Orson Cutler Shepard, professor of mineral sciencesr Reed Clark Rollins, associate professos of biological sciences; Robert Lewi; Bacon and William A. Bonner, assistant professors of anatomy and chemistry.

California Institute of Technology has adopted a new faculty salary plan based upon 12- rather than 9-month appointments, according to an announcement by Lee A. DuBridge, president. The plan will provide for a month's vacation and leave of absence either with or without pay, depending upon the type of work to be done by faculty members during such periods. The new appointment plan will enable faculty members to do research, study, preparation of course material, teaching, student supervision, and administration work on or off campus during the summer months. This plan, which will also include substantial salary increases, will become effective July 1.

Simmons College, Boston, has announced the following promotions, to become effective July 1: Philip M. Richardson, to professor of biology; Julian L. Solinger, to associate professor of biology; and Shirley T. Northrup, to assistant professor of chemistry. New appointments to the faculty are: Mary P. Crumley, instructor in biology, and Yorick G. Hurd, instructor in physics.

Elections

The National Academy of Sciences elected the following officers during its annual meeting, held in Washington, D. C., April 28–30: Alfred N. Richards, University of Pennsylvania, president for a four-year term; F. E. Wright, Carnegie Institution of Washington, re-elected home secretary for a four-year term; W. Albert Noyes, University of Rochester, and Donald D. Van Slyke, Hospital of the Rockefeller Institute for Medical Research, members of the Council of the Academy for three-year terms.

Newly elected members of the Academy are: Luis W. Alvarez, professor of physics, University of California, Berkeley; Robert F. Bacher, U. S. Atomic Energy Commission, Washington, D. C.; Paul D. Bartlett, professor of chemistry, Harvard University; Jacob Bjerknes, professor of physics, University of California at Los Angeles; Francis G. Blake, dean of Yale University School of Medicine; R. Alexander Brink, chairman, Department of Genetics, University of Wisconsin; Ralph W. Chaney, professor of paleobotany and curator of paleobotany, Museum of Paleobotany, University of California, Berkeley; Arthur C. Cope, professor in charge of Department of Chemistry, Massachusetts Institute of Technology; Farrington Daniels, professor of physical chemistry, University of Wisconsin; Arnold Gesell, director, Clinic of Child Development, Yale University School of Medicine; James Gilluly, professor of geology, University of California at Los Angeles; R. B. Goldschmidt, professor of zoology, University of California, Berkeley; Samuel A Goudsmit, professor of physics, Northwestern University; C. H. Herty, Jr., research engineer and assistant to vice-president, Bethlehem Steel Company; Frederick L. Hisaw, professor of zoology, Harvard University; Wolfgang Köhler, professor of psychology, Swarthmore College; L. G. Longsworth, associate member, Rockefeller Institute for Medical Research; Edwin M. McMillan, professor of physics, University of California, Berkeley; Walter J. Meek, acting dean, Medical School, University of Wisconin; J. L. Oncley, director, Ultracentrifuge Laboratory, Harvard University Medical

School; Lars Onsager, professor of chemistry, Yale University; John P. Peters, professor of medicine, Yale University; Paul A. Smith, professor of mathematics, Columbia University; C. Richard Soderberg, professor of applied mechanics, Massachusetts Institute of Technology; Paul Weiss, professor of zoology, University of Chicago; F. W. Went, professor of plant pathology, California Institute of Technology; Robert E. Wilson, chairman, Board of Directors, Standard Oil Company of Indiana; and E. Bright Wilson, Jr., professor of chemistry, Harvard University.

New foreign associates of the Academy are: P. A. Alexandroff, professor of mathmatics, University of Moscow; K. Linderstrøm-Lang, head, Chemical Division, Carlsberg Laboratory, Copenhagen, Denmark; J. N. Bronsted, professor and director, Institute for Physical Chemistry, Copenhagen, Denmark; Björn Helland-Hansen, director, Geophysical Institute, Bergen, Norway; and Frederic Charles Bartlett, director, Psychological Laboratory, Cambridge, England.

Walter D. Lambert, U. S. Coast and Geodetic Survey, president of the International Association of Geodesy, on January 13 was elected a correspondent of the Paris Academy of Sciences, Institut de France, in the Section of Geography and Navigation. He succeeds Father Pierre Lejay, who was elected a nonresident member of the Academy.

Wendell G. Scott, associate professor of clinical radiology at Washington University School of Medicine, has been re-elected president of the St. Louis Radiological Society for 1947.

The Hawaii Chapter of the Society of the Sigma Xi was officially installed March 19 in Honolulu during the University of Hawaii's 40th anniversary celebrations. Harlow Shapley and Karl T. Compton installed the following officers: John H. Beaumont, director of the University of Hawaii Agricultural Experiment Station, president; Robert W. Hiatt, associate professor of zoology, vice-president; O. A. Bushnell, assistant professor of bacteriology, secretary-treasurer; and Janet Smith, associate professor of education, and C. E. Pemberton, chief entomologist, Hawaiian Sugar Planters' Association, councilors.

The Hawaii Chapter is the 98th chapter to be formed and the first to be recognized by the national society beyond the continental limits of North America.

The Eastern Psychological Association elected the following officers at its meeting in Atlantic City on April 25–26: J. McV. Hunt, Institute of Welfare Research, Community Service Society of New York, president, 1947–48; Harold Seashore, Test Division, Psychological Corporation, secretary, 1947–49; Weston A. Bousfield, University of Connecticut, treasurer, 1947–50; O. Hobart Mowrer, Graduate School of Education, Harvard University, and Helen Peak, Connecticut College for Women, directors, 1947–50.

Recent Deaths

Morgan Brooks, 86, professor emeritus of electrical engineering at the University of Illinois, died April 23 in Washington, D. C.

Sir Almroth Wright, 85, fellow of the Royal Society and former director of the Institute of Pathology, St. Mary's Hospital, London, died at his home, Farnham Common, Buckinghamshire, on April 30. Sir Almroth originated the system of inoculations for typhoid, enteric tuberculosis, and pneumonia and developed methods to measure their effects on the blood.

Abel Joel Grout, 80, bryologist and author of many books on mosses, died March 27 in East Bradenton, Florida.

The 50th annual volume of *The Bryologist*, journal of the Sullivant Moss Society, will be dedicated to Dr. Grout, founder of the journal and co-founder of the Society, according to an announcement by the editor, W. C. Steere, Department of Botany, University of Michigan. It is expected that the special anniversary issue will contain more than twice its usual number of pages.

J. Hunter Gooding, Jr., 55, sales manager of the Semesan Division, Grasselli Chemicals Department, Du Pont Company, died April 14 after an illness of more than a year.

Discovery of an Upper Pleistocene Human Skeleton at Tepexpan, Valley of Mexico

The studies on Early Man in the Valley of Mexico which have been carried out by the writer since November 1945 with the aid of the Viking Fund, Inc., of New York, and with the cooperation of the Instituto Nacional de Geologia and the Instituto de Antropologia e Historia in Mexico City, reached a successful climax on February 22 with the discovery of a fossil human skeleton in the Upper Pleistocene Becerra formation near the village of Tepexpan, in the State of Mexico. The well-fossilized bones were found in an excavation at a depth of 1.12 meter in a buff-colored, silty clay—the same layer which had previously yielded several skeletons of the imperial elephant.

The geologic position and preservation of this fossil is such as to exclude all possibilities of intrusive burial or redeposition. It was found 30 cm. deep below the caliche formation, which in this region marks the beginning of the early Recent period. The caliche was diagnosed first by Prof. Kirk Bryan, of Harvard University, as a dry-climate fossil soil which represents the same dry climatic phase recognized by Dr. E. Antevs in the American Southwest and dated by him as 10,000 years old. The preceding Becerra formation represents the last Pluvial, when the Valley of Mexico was occupied by a lake whose beaches are preserved near the site. The fossil-bearing layer marks the closing phase of the Becerra Pluvial, when the lake level had fallen and a swampy lagoon had formed near Tepexpan. It is presumed that an entire herd of mammoth was trapped on the swampy ground and that prehistoric man was somehow involved in the event.

The precise location of the excavation was given by a preliminary geophysical survey carried out by Dr. Hans Lundberg, of Toronto, Canada. The spot marked the point of greatest electrical resistance offered to an alternating current artificially introduced into the ground in the manner of the linear electrode method. Without this geophysical survey the fossil could not have been located, since the ground offered no clues other than the presence of several buried mammoth remains found scattered over a portion of a flat lake plain 3,000,000 square meters in extent. To my knowledge, this is the first successful application of a geophysical device in the search for Early Man. The total cost of the instruments did not exceed $600. The plotting of equipotential lines between two electrodes took 9 days, but might have been done more quickly had various demonstrations not interrupted Dr. Lundberg's survey.

The position of the skeleton suggests that the person, an adult male, met with an accidental death. The body lay doubled up with legs drawn up to the chest, face downward, and must have sunk partially into mud so that the buried portion escaped the scavanging action of animals which may be held responsible for carrying off the feet, hip bones, most of the chest, backbones, and shoulder blades. Such an explanation would account best for the peculiar preservation and position of the buried skeletal remains.

In this connection it is of interest to note that the writer had previously found stone and bone artifacts at three different localities in the Becerra formation. These were found in deposits containing rolled bones of elephant, bison, horse, and *Glyptodon*. Equally interesting is the fact that a small flake of obsidian was found by Ing. A. R. V. Arellano with an elephant skull some 1,000 feet distant from the new site. A fragmentary, Folsom-like point was found on the hillside near by. The artifacts from the Becerra formation include three gravers, a scraper, and a bone point.

The fossil human remains are now in the Museo Nacional de Antropologia, Mexico City. Dr. J. Romero and Miss Johanna Faulhaber cleaned the remains of the clay matrix, and Dr. Romero has given me a tentative identification. While the facial portion of the skull and the lower mandible are broken, complete reconstruction appears possible. Besides the skull there are the following, partly fragmentary bones: 2 femurs, 2 kneecaps, 2 broken tibiae, 2 fibulae, 2 collar bones, 3 small rib fragments, 1 atlas and 3 fragmentary cervicals, 2 humeri, 1 complete right radius and 1 fragmentary left radius, 2 broken ulnae, 7 wrist bones of both hands, 5 metacarpals of both hands, and 13 finger bones.

A preliminary measurement of the skull showed it to be of mesocephalic type. It is peculiarly high but does not bear any truly primitive features.

The excavation site and vicinity have been mapped by Mr. Kenneth Segerstrom, topographical engineer of the U. S. Geological Survey, on a scale of 1:5,000. The site was visited during the first week after its discovery by Dr. Clarence Ross and Mr. C. Fries of the U. S. Geological Survey, Drs. Gordon F. Eckholm of the American Museum of Natural History, Henry Field, Alfonso Caso, Eduardo Noguerra, Dr. de la Borbolla, and Ing. R. Manges Lopez, director of the Instituto Nacional de Geologia. (HELMUT DE TERRA, *Calle Tigris, Mexico, D. F.*)

Since the receipt of Dr. de Terra's note on the Tepexpan discovery Dr. Franz Weidenreich has made a preliminary report on the anatomical character of this skeleton. His report follows:

The general character of the bones indicates that the individual belongs to the recent human type (*Homo sapiens*).

Although the skull does not reveal any special primitive feature characteristic of early hominids (the total calvarial height being about 140 mm.—rather noteworthy considering the size of the skull), there are some structural peculiarities which are more primitive than those usually found in modern human skulls. The frontal and occipital superstructures are well developed. Both come very close to real torus formations. The frontal superstructure consists of a distinct eyebrow ridge on both sides. The ridge extends to the glabella region and turns downward to the frontonasal suture, forming a well-marked supranasal torus such as occurs in the Australian bushman of today and in other "primitive races." The supraorbital ridges proper show an advanced stage of deterioration, but the original character of the ridge is easily recognizable. The occipital bone exhibits a typical occipital torus which resembles even the condition found in Neanderthal skulls. Similar primitive features are recognizable at the nuchal peanum, the mastoid, and the parietal region (temporal line).

These primitive features are not restricted to the brain case. They occur also in the extremity bones in which they appear under the form of pronounced muscular tuberosities (deltoid tuberosity of the humerus, crista interossea, and crista musculi pronator quadratus of the radius).

The facial skeleton does not show any special primitive features. There is neither a general nor an alveolar prognathism. The teeth, so far as they are preserved, are those of modern man.

Regarding special racial characteristics, the present condition of the facial parts does not permit a definite diagnosis. The nasal bones are "pinched," a peculiarity frequently encountered in certain Mongoloid types (Eskimo). The cheekbone, on the other hand, is small and does not project to a marked extent neither forward or sideward. The crows of the upper incisors are not preserved; hence, it is impossible to recognize whether or not these teeth were shovel shaped (Mongolian characteristic).

The brain case has a particular form: the vertex region is pronouncedly domed without showing any indication of artificial deformation. This shape may help to determine the special group to which the skull must be attributed.

None of the bones is very robust; on the contrary, they rather appear to be of a generally fine structure. Although this suggests female sex, the strongly developed muscular tuberosities prove that the individual was a male.

The tentative estimation of the cranial capacity is from 1,350 to 1,450 cc.

Taking all morphological facts into consideration, as far as it is possible to do so at this moment, it can be stated that none of them contradicts the possibility that the Tepexpan skeleton is that of an individual who lived at the end of the Pleistocene period. All the skeletons of Upper Paleolithic man known from Europe, Asia, and Africa already show the features characteristic of recent mankind. In most cases really primitive characteristics are completely missing. Wherever features were found recalling primitive conditions, they showed a more or less pronounced degree of deterioration, as is the case with the Tepexpan man.

Because of the inconclusiveness of the anatomical character of the skeleton, its identification as one of Pleistocene age cannot be based on anatomical evidence alone. An important criterion in this respect is the degree of fossilization of the bones. All the bones of the Tepexpan skeleton are mineralized, but the degree of mineralization varies: the lower jaw, for example, shows a higher degree than the brain case and the remaining facial bones. In the extremity bones, the mineralization led to a complete metamorphosis of the internal structure of the compacta, such as is typical of human bones from the Middle Pleistocene of China and Java.

If the stratigraphy of the Tepexpan skeleton proves the Pleistocene age, the anatomical character and the degree of its mineralization lends strong support to this assumption.

Meetings of Affiliated and Associated Societies

The following list of meetings is based on reports submitted to AAAS headquarters by society secretaries:

Section A: Mathematical Association of America, September 1–2, New Haven, Connecticut; Institute of Mathematical Statistics, December 26–31, Chicago, Illinois; American Mathematical Society, December 29–31, University of Georgia, Athens.

Section B: American Association of Physics Teachers, June 18–21, University of Minnesota, Minneapolis, and December 26–31, Chicago; American Society for X-Ray and Electron Diffraction, June 23–25, Montreal, Canada; Society of Rheology, October 30–31, New York City; American Physical Society, December 26–31, Chicago; Sigma Pi Sigma, December 26–31, Chicago.

Section C: American Association of Cereal Chemists, May 19–23, Kansas City, Missouri; American Oil Chemists' Society, May 20–22, New Orleans, Louisiana; American Chemical Society, September 15–19, New York City; American Institute of Chemical Engineers, November 9–11, Detroit, Michigan.

Section D: The Meteoritical Society, June 16–21, San Diego, California; American Astronomical Society, September, Evanston, Illinois.

Section E: American Society for Professional Geographers, December 27–30, Charlottesville, Virginia; Association of American Geographers, December 29–31, Charlottesville; Geological Society of America, December 29–31, Ottawa, Canada; Paleontological Society, December 28–31, Ottawa; National Council of Geography Teachers, December 27–29, Charlottesville.

Sections F and FG: Federation of American Societies for Experimental Biology, May 18–22, Chicago; Western Society of Naturalists, June, San Diego; Herpetologists League, June 16–21, San Diego; American Society of Mammalogists, August 24–27, Higgins Lake, Michigan; American Malacological Union, American Microscopical Society, American Society of Naturalists, American Society of Parasitologists, Ecological Society of America, Entomological Society of America, Genetics Society of America, Linological Society of America, National Association of Biology Teachers, Phi Sigma Society, and Union of American Biological Societies, December 26–31, Chicago; Beta Beta Beta, December 27–28, Chicago; American Society of Zoologists, December 29–31, Chicago.

Section G: American Fern Society, American Society of Plant Physiologists, American Society of Plant Taxonomists, Botanical Society of America, Inc., Mycological Society of America, and Sullivant Moss Society, December 26–31, Chicago; American Phytopathological Society, December 28–30, Chicago.

Section H: American Folk-Lore Society, December, Detroit, Michigan; American Anthropological Association, December 27–30, Toronto, Canada; Archaeological Institute of America, December 29–31, New Haven, Connecticut.

Section I: American Psychological Association, September 9–13, Detroit; Society for Research in Child Development, December 27, Chicago.

Section K: Population Association of America, May 17–18, Princeton, New Jersey; Econometric Society, September, Washington, D. C., and December 26–31, Chicago; Academy of World Economics, December 26–31, Chicago; American Sociological Society, December 28–30, New York City; American Statistical Association, December 26–31, Chicago; Pi Gamma Mu, December 26–31, Chicago; American Economic Association, December 27–30, Chicago; Metric Association, Inc., December 27, Washington, D. C.

Section L: History of Science Society, December, Cleveland, Ohio; Philosophy of Science Association, December 26–31, Chicago; American Philosophical Association, December 28–31, New York City.

Section M: American Society of Heating and Ventilating Engineers, June 1–4, Coronado, California; American Society of Refrigerating Engineers, June 9–11, Los Angeles, California; American Institute of Electrical Engineers, June 9–13, Montreal, Canada; American Society of Mechanical Engineers, June 16–19, Chicago; Society for the Promotion of Engineering Education, June 19–21, Minneapolis, Minnesota; American Society of Agricultural Engineers, June 22–25, Philadelphia, Pennsylvania; Illuminating Engineering Society, September 15–19, New Orleans, Louisiana.

Section N: Society of American Bacteriologists, May 13–16, Philadelphia; American Society of Experimental Pathology, May 17–22, Chicago; American Physiological Society, May 18–22, Chicago; American Psychiatric Association, May 19–23, New York City; American Medical Association, June 9–13, Atlantic City, New Jersey; American Association of Dental Schools, June 23–25, Chicago; American Association of Colleges of Pharmacy, August, Milwaukee, Wisconsin; American Veterinary Medical Association, August 18–21, Cincinnati, Ohio; American Pharmaceutical Association, August 24, Milwaukee; American Roentgen Ray Society, September 14–19, Atlantic City; American Public Health Association, October 6–10, Atlantic City; American Academy of Ophthalmology and Otolaryngology, October 12–17, Chicago; American Dietetic Association, December 26–31, Chicago.

Section O: Association of Official Seed Analysts, June 2–5, Richmond, Virginia; Agricultural Institute of Canada, June 23–26, Lethbridge, Alberta; American Dairy Science Association, June 24–26, Ontario, Canada; American Society of Animal Production, November 28–29, Chicago; Society of American Foresters, December 18–20, Minneapolis; American Society for Horticultural Science, December 26–31, Chicago; Potato Association of America, December 27–29, Chicago.

Section Q: Pi Lambda Theta, August 10–13, Portland, Oregon; Canadian Teachers' Federation, August 11–15, Halifax, N. S.; National Science Teachers Association, December 26–31, Chicago; Phi Delta Kappa, December 27–31, Kansas City, Missouri.

All Sections: Research Council on Problems of Alcohol, May, New York City, and December 26–31, Chicago; American Nature Study Society, Sigma Delta Epsilon Graduate Women's Scientific Fraternity, and Society of the Sigma Xi, December 26–31, Chicago.

TECHNICAL PAPERS

Chemotherapeutic Investigations of Cyanine Dyes

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L. A. Sweet

*Research Laboratories, Parke, Davis & Company,
Detroit, Michigan*

Although extensive investigations have been carried out on the chemotherapeutic properties of the cyanine, styryl, and related dyes by Prof. Browning and his collaborators at the University of Glasgow (*1*), the chief use of these dyes has remained in the field of photography, where they are indispensable as color sensitizers. Because of their significance in this connection, a very large number of new dyes of these classes has been prepared during the past 20 years in the Research Laboratories of the Eastman Kodak Company, in the department of one of us (L. B.) who, prompted by the earlier work of Browning, was eager to see the pharmacological investigations extended and the newer cyanine dye types in particular given adequate chemotherapeutic testing. An arrangement was reached whereby certain representative compounds were prepared[1] in a suitably soluble form and submitted for extensive testing.

Some of the dyes were supplied to the National Research Council Chemotherapy Center for Tropical Diseases for testing against the organisms of such diseases. The most striking fact to emerge from the investigations which ensued was the pronounced antifilarial and anthelmintic activities of many of the cyanine types.[2] Many of the dyes also showed antimalarial activity, but not such as to equal that of drugs already available. The antimalarial results have been reported (*2*).

Another extremely interesting activity was noted in our laboratories when (1-amyl-2,5-dimethyl-3-pyrrole) (1,6-dimethyl-2-quinoline) dimethinecyanine chloride was tested *in vitro* against the lactic acid-producing bacilli.[3] This cyanine dye completely inhibited the growth of *Lactobacillus casei* at 2×10^{-6} M. *L. arabinosus* was inhibited by a concentration of 2×10^{-6} M, *Streptococcus faecalis* by 4×10^{-6} M, and *Escherichia coli* by 3×10^{-6} M. The inhibition of *E. coli* by 3×10^{-6} M concentration of cyanine dye was partially reversed by 100 mg./100 cc. of vitamins B_1 and B_2, nicotinic acid, and pantothenic acid. The reversal by crude yeast and liver extracts was even greater than indicated by their vitamin content. Vitamin B_6 and p-aminobenzoic acid were without effect on the inhibitory action of the dye.

In order to determine the nature of the bacterial inhibition, the effect of the cyanines on various enzyme systems was studied. There was no appreciable effect on the d-amino acid oxidase, cytochrome oxidase-cytochrome C, succinic dehydrogenase, glucose dehydrogenase, lactic dehydrogenase, and liver glyoxalase enzyme systems.

Representative dyes were also tested *in vivo* for activity against *Str. hemolyticus*, *Str. viridans*, *Staph. aureus*, *Diplococcus pneumoniae I*, *Trypanosoma equiperdum*, *Treponema pallidum*, St. Louis encephalitis, influenza, typhus, and other viruses, and a group of intestinal parasites; also *in vitro* against *Endamoeba histolytica*.[3] While an occasional compound showed some demonstrable activity against these organisms, the order of activity was not sufficiently great to be therapeutically significant.

A summary of the cyanine, styryl, and related dyes studied will be supplied on request.

References

1. Browning, C. H. *Edinb. med. J.*, 1937, N.S. 44, 497.
2. Wiselogle, F. Y. (Ed.) *A survey of antimalarial drugs.* Ann Arbor, Mich.: Edwards Bros., 1947.

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[1] The dye syntheses were carried out by E. Van Lare, R. H. Sprague, F. L. White, G. H. Keyes, and Miss G. VanZandt, to whom the authors acknowledge their indebtedness.

[2] These investigations will be reported at the May meeting of the Federated Biological Societies in Chicago by R. N. Bieter and A. D. Welch and their associates.

[3] The authors acknowledge the work of F. D. Stimpert, O. M. Gruhzit, O. D. Bird, and G. Rodney, of the Research Laboratories, Parke, Davis & Company, under whose supervision many of these tests were performed.

Hereditary Obesity and Efficient Food Utilization in Mice[1]

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J. W. Gowen

Iowa State College, Ames, Iowa

Energy costs of transferring food materials into body tissues constitute a recurrent problem of genetics, nutrition, and physiology. The specific problem of inherited fatness in relation to efficiency of food utilization came to our immediate attention in a study of rate and economy of gain and carcass composition of swine (*3*). It was found that the hereditary influences which reduced the food required per pound of gain also increased the proportion of the gain that was fatty tissue. These results were at variance with the supposition that food requirements would be larger for deposition of fatty tissue, because of its higher energy content, compared with nonfatty tissue. This supposition apparently holds for the

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[1] Journal paper No. J-1422 of the Iowa Agricultural Experiment Station, Ames, Iowa; Project No. 252.

This work was aided by a grant from the Rockefeller Foundation.

increase in fat deposition during the later stages of development of a given animal. However, we were concerned with the effect of hereditary differences in the composition of weight gains on food required per unit of gain among different animals at a similar stage of growth. This may involve heritable differences in food consumption and in energy expended for activity and other body work, as well as differences between fat, carbohydrate (*5*), and protein in the energy required for transfer from food to body tissue.

Because of certain limitations of the swine data and the broad implications of the findings, it became desirable to study more critically the nature of inherited fatness in relation to food utilization. The marked adiposity induced in mice by the "yellow" gene (*2*) seemed to offer unusual opportunity for the controlled experiment (*4*) which is reported briefly here.

Because yellow coat color in the mouse is produced by a dominant autosomal gene in the heterozygous condition, crosses to nonyellow mice give approximately equal numbers of yellow and nonyellow progeny within each sex. Accordingly, yellow and black agouti segregates were obtained by crossing yellow males of a highly inbred stock, kindly provided by L. C. Dunn, with albino females of another highly inbred line of our own. The yellow and black littermates of the same sex differed presumably only in the one chromosome or portion thereof which carried the "yellow" gene. Sets of unmated yellow and black littermates were compared within each sex and growth period, the periods being from 25 days to 30, 50, 90, 200, and 300 days of age. Each such series of comparisons was replicated four times, at approximately monthly intervals, to measure seasonal and litter variation in the results. A total of 62 yellow and 65 black mice were used. The mice were self-fed in individual cages to permit full expression of genetic differences in appetite as well as in utilization of food consumed. The only food was a complete, finely ground ration fed in shallow jelly glasses with access through a hole in the cover. The shelves containing the feeding cages were completely enclosed by fine screen to prevent food loss to stray mice. Feces, urine, and spilled food were recovered on waterproofed paper trays. Live weight gains, food consumption, and feces production were obtained by 10-day periods from 30 to 50 days and by 20-day periods thereafter. At the close of its feeding period each mouse was chloroformed, and its whole body was analyzed for fat, nitrogen, water, and total dry matter by Prof. Wilkinson, of our Experiment Station chemistry staff. Body composition was also obtained for yellow and black mice from two litters within each sex at 25 days of age.

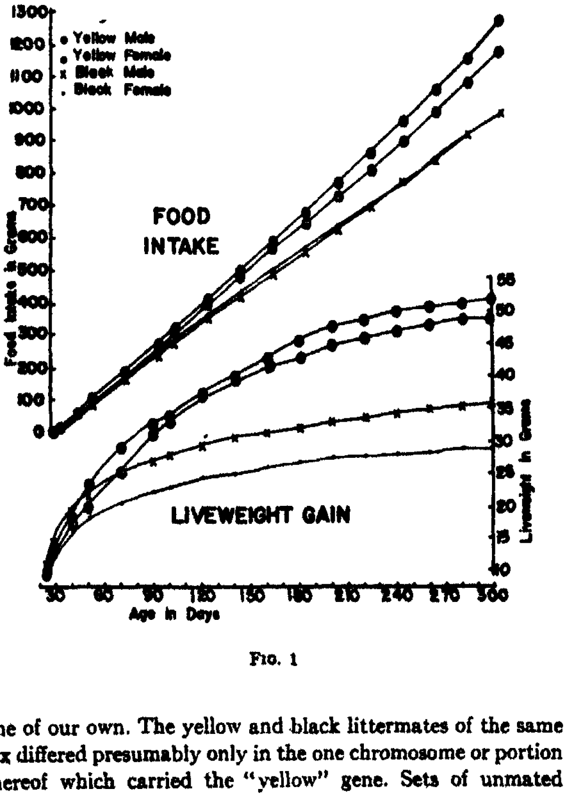

FIG. 1

The curves in Fig. 1 show the average gain and food consumption for all sets of yellow and black littermates within each sex and age. From 25 to 35 or 40 days of age, yellow and black mice of the same sex were nearly alike in both gain and food consumption, and the gain was predominantly protein. After 40 days, yellow mice of both sexes exceeded their black littermates greatly in gains but only moderately in food consumption. It is evident from Fig. 2 that the extra gain of the yellow mice was entirely fat tissue. Hence, it is immediately clear that the "yellow" gene greatly increases the energy stored per gram of gain but at the same time sharply reduces the food required per gram (and even more so per calorie) of gain. For example, during the period from 40 to 90 days of age, food requirements per gram of gain were only .44 as much for yellow as for black females and .66 as much for yellow as for black males. The greater efficiency of the yellow mice is even more pronounced when the comparison is made from weaning to a fixed final weight, so that the faster gain of the yellows directly reduces the number of days fed. For example, from 25 days to a final weight of 25 grams in females and 30 grams in males, the ratios of food consumed per gram of gain by yellow to that by black mice were .38 in females and .51 in males.

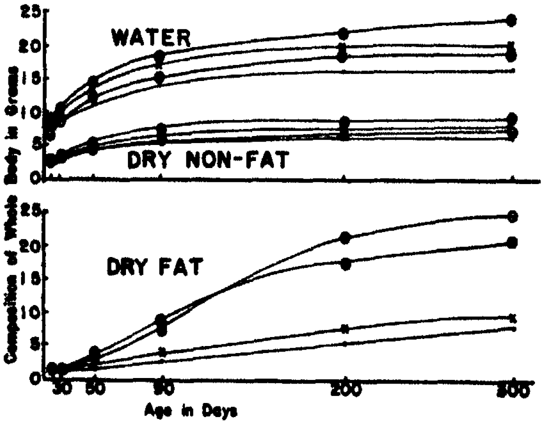

FIG. 2

The yellow gene accomplished the increased fat deposition and the lowered food requirement per unit of gain by increasing the appetite slightly and reducing the energy expended in body work, especially in activity, beginning at 35 or 40 days of age. Rytand (*9*) also observed this increased appetite of yellow mice. Judging by the weights and average composition of feces, the percentage of the food calories eliminated in the feces (and in the urine absorbed by the feces) ranged from about 19 in the 25–30-day period to about 23 in the 25–300-day period. It was slightly lower for black females than for the other three groups, perhaps because more urine was absorbed by spilled food and less by feces for the former. Thus, the increase in nutrients absorbed by yellow, as compared with black, mice was nearly in proportion to the increase in food consumption. Furthermore, the increase in energy expended in body work by the yellow mice was proportionally much less than the increase in their average body weight, particularly in females. For example, the increase of yellow over black mice in calories absorbed from 25 to 300 days of age was 20 per cent in females and 34 per cent in males, whereas the increase in calories stored in the body was 210 and 114 per cent, respectively. Energy used for body work (food less feces and gains) increased only 15 per cent in females and 32 per cent in males compared with increases of 56 and 39 per cent, respectively, in average body weight for the period. Taking calculated energy expended in body work per unit of average body weight as 1.00 for black females, relative values for black males and for yellow females and males were .82, .74, and .78, respectively. Similar results were obtained during periods when mature mice (usually over 180 days of age) made little or no change in weight. Here it was found that food requirements per gram of body weight were only .75 as large for yellow females and males and .87 as large for black males as those for black females. These results corresponded with our observation throughout the experiment, that black females were much more excitable and active than yellow females or males, with black males intermediate. The amount of food thrown from the dishes provided a crude index of activity. Limited observations on mature mice indicated that daily food spillage per gram of body weight was 1.3 grams for black females but only .20, .05, and .17 gram, respectively, for black males and for yellow females and males.

The data emphasize how little of the food energy is stored in the body compared with that used for the maintenance and activity of the body. Energy stored as fat and protein represented only 2–11 per cent of the total food energy during the several periods from 25 to 300 days of age, whereas energy expended in body work represented 70–80 per cent. Of the total calories consumed, the yellow mice stored 2–5 per cent more than their black littermates and used at least that much less for body maintenance and activity. A relatively small reduction in maintenance food thus causes a large increase in food stored.

The work of Miss Weitze (*11*) has only recently come to our attention. Her results agree closely with ours with respect to the effect of the "yellow" gene on the rate and composition of gain and on appetite. However, she found no effect on activity as measured by a treadmill or on food energy used for maintenance and activity per unit of body weight. These discrepancies may be due to inadequacy of a treadmill for measuring natural activity and to the fact that metabolism data was obtained for only one yellow mouse of each sex, using average figures for composition of the gains. Her results from parabiosis, hypophysectomy, and histological studies indicate that the action of the "yellow" gene is hormonal, involving altered carbohydrate metabolism.

There is evidence that the action of the "yellow" gene is similar to that of the genes affecting fat deposition in animals generally. Recent correspondence with Miss Kennedy indicates that the strain of rats produced at the Minnesota station (*7*) by selecting for efficient food utilization gained more rapidly and required about 30 per cent less food per gram of gain and unit of body weight than the strain selected for inefficient gains, under full feeding. The extra gain of the "efficient" strain was largely fat tissue. Further evidence is provided by MacArthur's (*6*) selection for slow and for rapid growth to 60 days of age in two strains of mice. After 8 generations, mice of one strain were twice as large as those of the other, and mice of the large strain "tend to become sluggish and obese," whereas mice of the small strain "are very active and aggressive," suggesting a difference in metabolic rate. Differences in activity rather than in resting metabolism are indicated by Benedict's (*1*) finding that the heat production of resting mature mice per unit of calculated surface area (¾ power of weight) was the same for an exceedingly fat race (MacDowell's CHS Silvers, not "yellows") as for common laboratory and wild mice. Salcedo (*10*) found that mice of this same fat race oxidized tissue fat more slowly than normal mice when starved and interpreted this slower fat oxidation by the fat race as the cause of their obesity. However, both could be the result of inherently smaller energy requirements. Ritzman and Colovos (*8*) have shown how strikingly the genetic association of fatness with efficient gains is exemplified in the pig, as contrasted with sheep and cattle, because of its greater appetite and reduced heat losses and activity.

The evidence presented indicates that the "yellow" gene in mice reduces food requirements per unit of gain and produces obesity, primarily by increasing the food intake and by reducing energy expended, especially for activity. Both of these effects increase the energy available for storage as fat, whereas the first raises only slightly, and the second reduces, the energy dissipated in body work. Hence, the "yellow" gene causes gain in weight to increase much more than total food consumption, even though the extra gain is fat tissue containing more energy per unit of weight than other tissues. These results emphasize the distinction between the hereditary association of increased fat deposition with lower food requirements per unit gain in weight and the developmental association of increased fat deposition with higher food requirements. Hereditary obesity is the result of more efficient food utilization.

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A Serological Study of Influenzal Antibodies[1]

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The purpose of this preliminary report is to give the data obtained from a survey of a population for antibodies to the influenzal agents A, B, and swine. These studies were initiated in order to ascertain the type of influenza strain that would manifest itself in the anticipated epidemic. That an epidemic of influenza was probable was dependent upon the findings that epidemics usually occur in cycles (*1*). The possibility of this epidemic being due to influenza B appeared remote in view of these cycles and past findings (*2*, *3*). The consensus was that if an epidemic occurred, it would be due to influenza A.

MATERIALS AND METHODS

The strains and method of growth of these viruses[2] were the same as those described in a previous report (*3*).

One hundred random specimens of serum were taken from the serological service each week, starting the first week in September 1946. The original blood samples from which these sera were obtained were submitted to the Bureau of Laboratories for routine serological tests for syphilis.

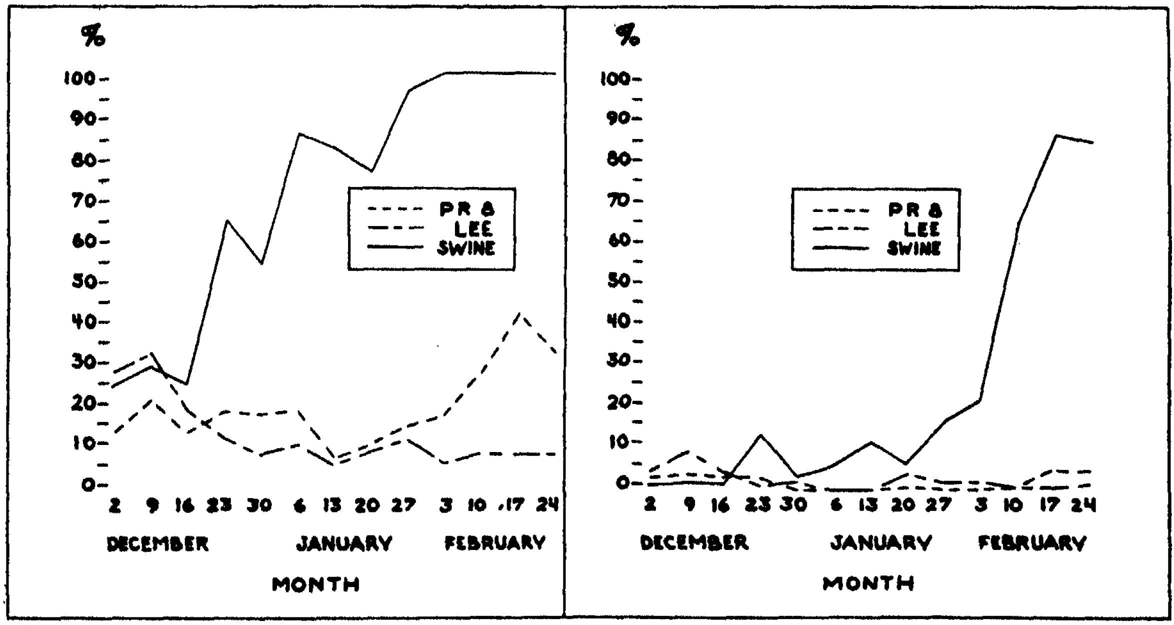

FIG. 1. Percentage sera with titers of 400 and 4,000 (final dilutions).

Our procedure for the Hirst test was that suggested by Salk (*4*), but only three dilutions of the serum were tested. The sera were diluted in saline to make initial dilutions of 1:100, 1:500, and 1:1,000. To 0.5 ml. of serum dilution, 0.5 ml. of virus dilution (4 units) was added. To this mixture, 1.0 ml. of chicken erythrocytes (1 per cent) was added, and the test read after 75 minutes at room temperature. The presence or absence of a "button" was used to denote inhibition or agglutination.

RESULTS

Titrations of the sera obtained during September showed a rather high percentage of antibodies for influenza B, especially in the lower dilution. This level gradually decreased until it approximated the influenza A and swine influenza levels. There was little evidence of any antibody changes until the middle of December. A significant change then became apparent, with a steady increase in the number of individuals having antibodies to the swine virus. This increase was first noticed in the 1:400 dilutions of sera. Significant increases in dilutions 1:2,000 and 1:4,000 were not apparent until the middle of January. At this time, every serum tested showed at least a 1:400 antibody titer.

Fig. 1 shows this increase in antibodies among the population. Only that portion of the graph pertinent to the critical period is given here. It appears quite evident that the population in general has responded with antibodies specific for the swine virus. The determination of the cause for this increase in antibodies is difficult. At the time of this antibody increase there was no evidence of clinical epidemic influenza, a condition which still exists. Several volunteers donated blood samples, and the majority of these demonstrated titers above a final serum dilution of 1:2,000. There did not appear to be any relationship between the titers for the swine virus and a history of vaccination with commercial influenza A and B vaccine.

DISCUSSION

The results were quite unexpected. Studies of the relationship of this swine virus to strains of influenza A and to man are now in progress. Clinically, there was no evidence of epidemic influenza in this area. The only apparent evidence of

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[1] Aided by a grant from the Hendricks Research Fund.

[2] The PR8 and Lee strains were supplied by Dr. Werner Henle; the swine strain, by Dr. Gilbert Dalldorf.

infection in the population, concurrent with the antibody increase, was a marked increase in apparently typical coryza.

It is realized that controls in a study of this sort are difficult. At present we are engaged in studies on sera that had been collected before and after this increase in antibodies became apparent. In addition, throat washings have been obtained from several individuals with this antibody increase, and attempts at virus isolation are being made.

Addendum: Since submission of this report an epidemic of influenza has occurred in this area. Studies are now in progress as to the etiology of this epidemic and its relationship to the above findings.

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A Bacterial Disease of the Lobster (*Homarus americanus*)

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During the summer of 1946 lobster dealers in Maine suffered considerable losses due to heavy mortality of lobsters held in pounds and tanks. A spot survey indicated that losses attributable to a new disease varied from 20 to about 50 per cent and that the disease was widely distributed along the coast of Maine.

It was suspected at first that these losses might be caused by the use of DDT in some of the fish canneries. Some of the offal from the canneries, which is used as bait and food for the captive lobsters, might contain toxic amounts of DDT. Microscopic and bacteriologic examination of the diseased lobsters indicated, however, that it was more likely that the disease was caused by a bacterium belonging to the genus *Gaffkya*. Wherever there was a considerable mortality of the lobsters at the time of examination, micrococci of the *Gaffkya* type were found in the blood smears and the blood culture. The blood needed for the microscopic examination and for isolation of bacteriologic media was removed by a puncture from the ventral abdominal sinus with a sharp, pointed, Pasteur pipette following surface disinfection of the thin membrane between the somites of the abdomen.

The diseased lobsters had a pink discoloration of the ventral side of the abdomen; the blood was also pink, less viscid, and usually with much-prolonged clotting time. In advanced cases, in which there was a large number of bacteria in the blood stream, the number of blood corpuscles was sharply reduced.

The severity of the disease appeared to be decreasing with the onset of colder weather. At certain pounds the infected lobsters predominated in September, but in October they could not be found in the same pounds. However, an outbreak of the disease with typical symptoms, high mortality and the presence of *Gaffkya*, was reported in December.

The organism, which was regularly isolated from diseased lobsters in pure culture, could be grown fairly easily on the standard media. Solid and semisolid media prepared with the tryptic digest of casein and yeast extract gave very satisfactory results. On these the growth was reliable, but the amount of growth was always small. Colonies about 1 mm. in diameter, circular, convex, and grayish-white, were produced. In semisolid and liquid media scant granular sediment was produced. The organism neither changed litmus milk nor liquefied gelatin. It produced acid, but no gas, from mannitol, dextrose, sucrose, maltose, and lactose.[1]

In the fresh blood of the infected lobsters the organism was found to be present in tetrads surrounded by a wide pseudocapsule around the group. In media it produced irregular conglomerations without capsules. In stained preparations it was gram positive. It was also nonmotile.

A series of lobsters was inoculated intramuscularly and intravenously with the pure cultures of this microorganism. All inoculated lobsters died within two weeks with the typical symptoms of the disease, and from the blood of these lobsters the organism was reisolated in pure culture.

Two randomized experiments were made on the effect of the inoculation of normal lobsters and on the treatment of infected lobsters with sulfonamides, which have been found effective against some bacterial diseases of fishes (*1*). The lobsters were distributed, two to a tank, in randomized blocks. They were fed ground herring or redfish mixed with gelatin, to which sulfonamides or bacteria were added. Some were fed infected lobster.

The results, compiled in Table 1, indicate that the injection of pure culture of *Gaffkya*, isolated from diseased lobsters, invariably killed the lobsters within two weeks, even if they were treated with sulfonamides. Introduction of bacteria with food was ineffective, and sulfonamides seemed to reduce the mortality only among the lobsters which contracted the disease in a natural way.

TABLE 1

THE EFFECT OF ARTIFICIAL INFECTION OF LOBSTERS AND OF TREATMENT WITH SULFONAMIDES

Treatment	Initial No. of lobsters	No. 2 mortalities
Normal controls	30	2
Diet with bacteria (*Gaffkya*)	30	4
Normal controls		
Sulfamerazine	10	1
Sulfamethazine diet	10	1
Diseased controls	10	5
Diseased		
Sulfamerazine diet	10	1
Sulfamethazine diet	10	1
Normal		
Injected with bacteria	30	29
Injected with bacteria, sulfamerazine diet	10	10
Injected with bacteria, sulfamethazine diet	10	10
Injected with sterile medium	20	2
Fed infected lobster	10	1
Fed normal lobster	10	1

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[1] Detailed study of the organism is in progress at the Department of Bacteriology, University of Maine; the results will be published elsewhere.

IN THE LABORATORY

Improved Electrophoresis Cell and Cell Holder

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Those laboratories fortunate enough to possess a Tiselius electrophoresis apparatus frequently accumulate more work than they can handle because of the length of time required for each determination. Unless the cells are cleaned frequently and the sliding joints regreased, experiments may be spoiled by the development of leaks between the sections or at the neoprene connections with the electrode vessels. Much time may be saved by using a pair of the cells and cell holders, as shown in Fig. 1, which permit two electrophoresis experiments to be conducted simultaneously in one apparatus with a minimum of trouble from leakage. The double-length cells described by Longsworth, Cannan, and MacInnes (*1*) are particularly easy to manipulate for filling in this cell holder, and the danger of breakage is eliminated because the force required to slide the joints is applied directly at the edges of the sliding glass plates.

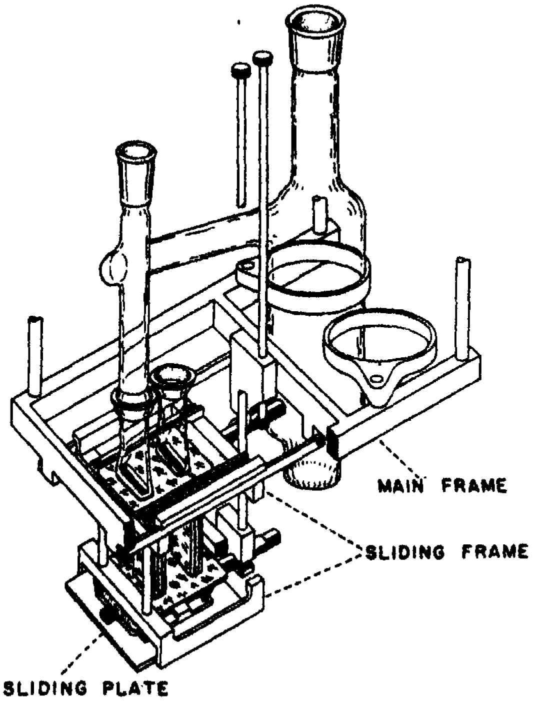

FIG. 1

The main frame of the cell holder carries a smaller sliding frame in which are held both the middle section of the cell and a device for manipulating the bottom section. When the right-hand knob at the top is turned, the corresponding rack and pinion move this sliding frame, thus opening or closing the connection between the middle and top sections without, however, affecting the lower joint. The top section is held in place by a removable holder (not shown) on the main frame, which has projections to locate the glass plate by the edges and springs to press the sliding joint together. Similarly, the left-hand knob and a second rack and pinion mounted on the sliding frame move a sliding plate in which is held the bottom section, thus operating the lower joint without affecting the top joint. This is in contrast to the operation of the usual cell holders in which a piston (*3*) or rack and pinion (*2*), by applying force near the center of the middle section, moves this section while both the top and bottom stay fixed. If the frictional forces at the two joints are not equal, the resultant torque tends to tilt the middle section and either open the joints or break the cell.

Much of the success of the new holder depends on mounting the cell so that there is no overconstraint. Attached to the sliding frame along opposite edges of the glass plates of the top joint are two guide bars, which keep the top and middle sections parallel with the frame. Six additional points of contact between the middle section and the sliding frame are provided by buttons (not shown) located at the midpoints of the two remaining edges of the top glass plate and the four edges of the bottom plate. Thus, the middle section is fixed and strain free relative to the sliding frame, except that it can move vertically to make contact with the bottom section. The bottom section is held in the bottom sliding plate which maintains alignment with the middle. This sliding plate, which holds the entire weight of the cell as well as the force of the springs on the top section, rides on a single point at its center so that the pressure between the sections of the cell is uniformly distributed over the entire area of the sliding joints. In the usual type of cell holder, the weight is carried by guides at both sides of the bottom, with the result that, unless the frame and cell conform exactly, the weight is actually carried at only one edge, and the bottom joint is held together only by the cohesion of the grease. Leakage usually develops after the joint has been slid only a few times. The use of such a one-point support in other types of holder or simple cushioning of the bottom section on soft rubber, as suggested by Svensson (*3*), would probably help. With the new holder, leakage has never been observed. Even after 20 consecutive runs on one occasion, there was no obvious leak, although the delicate test of electrical leakage was not applied.

The arrangement of the spherical glass connection with the electrode vessels is apparent from Fig. 1. In order that the joints may be assembled without strain, each electrode vessel is mounted with some freedom in a sling (not shown) under the ring holding the vessel to the main frame. This ring, in turn, is pivoted to allow some horizontal motion. By mounting both electrode vessels on the same side of the cell, two complete units can be put simultaneously in the thermostat bath with the cells adjacent. The frames are supported from the top on a track across the tank so that either cell may be rolled into position in front of the windows for observation. Spherical joints can be added to pre-existing equipment if the supports for the electrode vessels are given slight horizontal freedom. A method for making cells has been published (*5*). Pyrex glass plates, of course, must be used for cementing to the spherical joints.

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[1] Contribution No. 1120.

The cells and holders have been used successfully for several years in an electrophoresis apparatus using parabolic mirrors in the optical system, as described elsewhere (*4*).

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Administration of Micronized Therapeutic Agents by Inhalation or Topical Application

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There are many disadvantages to the present method of administering therapeutic agents by the aerosol principle. The major objections are: (1) the wasteful, expensive, and unnecessary use of oxygen merely as a source of pressure; (2) the fact that the manual methods are time consuming and tiring (20–30 minutes/dose); and (3) the fact that the penicillin solutions used deteriorate rapidly and must be kept refrigerated to retain full potency for one week.

A small ball mill (Fig. 1) has been built, using readily available materials, which will grind various therapeutic agents to a micronized state in two hours. The material is then bolted through fine-meshed silk bolting cloth. When 40–50 grams of the mixture is prepared by use of this apparatus, the loss is less than 10 per cent.

Several modifications of the apparatus for administration of the smoke have been devised. The final apparatus is shown in Fig. 2. The lower chamber contains drierite, which is a dehydrating substance (anhydrous calcium sulfate), with an indicator which turns from blue to pink when it has picked up all the moisture it can. The lower chamber is filtered on both ends to prevent the drierite from being blown into the smoke-producing chamber or from being drawn into the air-intake opening. The smoke chamber has been built with a small surface area to increase the emptying efficiency. The air vents into this compartment are placed at an acute angle to force the powder into a spiral path in order to create turbulence. The outlet tube is likewise made of small internal caliber to reduce the amount of precipitate on the walls of the tube. Various adapters (nasal, oral, dental, vaginal, etc.) can be fitted to the outlet tube. This equipment can be used as it stands or fitted with a rubber mouthpiece. In other words, no bulb is necessary, but the exit tube or rubber mouthpiece can be placed in the mouth, and, by inhaling through the apparatus, the finely divided therapeutic agents can be drawn into the lungs. Efficiency studies indicate that, when used correctly, the apparatus will deliver in the smoke form 95 per cent of the therapeutic agent originally placed in the cup and may be administered by the patient in from two to four minutes.

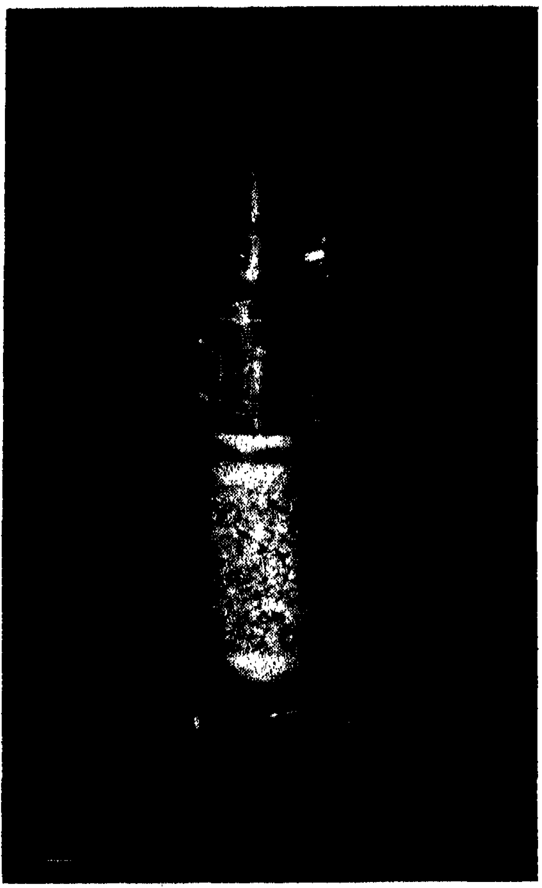

FIG. 1. The ball mill.

A disposable apparatus containing the principles of the smoke chamber may be molded very inexpensively by the use of one of the transparent plastics. This apparatus may be used as both container and dispenser for the penicillin or other therapeutic agents.

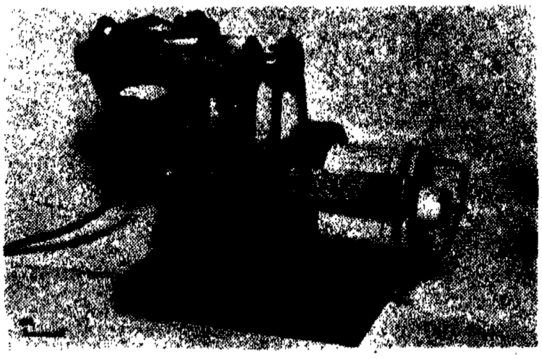

FIG. 2. The apparatus.

Blood penicillin concentrations were determined by the method described by Wolahan and Cutting (1). Results on the blood levels in subjects inhaling various doses of the micronized potassium penicillin-glucose preparation are shown in Table 1.

TABLE 1

Patient	Dosage (units of crystalline penicillin)	Interval after administration	Concentration (units/cc. citrated whole blood)
C*	30,000	½ hr. 1 "	.03 .03
T*	30,000	½ " 1 "	.06 .03
R*	50,000	½ " 1 " 2 "	.03 .03 .015
S*	50,000	½ " 1 " 2 " 3 "	.06 .03 .03 .03
L	25,000	½ " 1 " 2 "	.015 .015 .015
M	30,000	1 " 20 min. 2 "	.06 .06
P	30,000	1 " 2 "	.06 .03
B	160,000	1 " 2 " 4 " 6 " 8 " 10 " 12 "	.06 .03 .03 .03 .03 .03 .00
O'N	90,000	½ " 1 " 2 " 3 " 4 "	.125 .06 .06 .03 .06
H	90,000	½ " 1 " 2 " 3 " 4 " 5 "	2.000 .125 .125 1.000 (?) .060 .060

* Normal controls. Penicillin and penicillinase controls were performed.

In all cases except one (L) where 25,000 units or more were administered, a therapeutic concentration was obtained in ½ hour and maintained for about 3 hours. After large doses (B and O'N) the therapeutic levels are maintained for approximately 10 hours. In two cases studied it was found that 10–15 per cent of the dose administered was excreted in the urine in the first hour.

Any soluble therapeutic agent which can be produced in the solid state or which can be chemically precipitated or physically combined with glucose, β-lactose, lactose, etc. may be micronized and used in the manner described. Some of the agents meeting these requirements are: the sulfonamides; antibiotic agents such as penicillin and streptomycin; hormones such as insulin and estrone; antihistamine drugs such as Benadryl; vasoconstrictors such as neosynephrine and ephedrine; narcotics such as codeine and dilaudid; biologicals such as immune human globulin, vaccines, etc.; various medicinal compounds such as cough mixtures; and numerous others. These materials may be used individually or in compatible combinations, with or without a vehicle.

In certain diseases principally those in which a high local concentration of the agent at site of the infection or reacting organ is of great importance, this method of therapeutics is particularly advantageous. These include certain diseases of the respiratory tract, topical application where indicated, allergic states, and urinary tract infections. The method is also useful in the prophylaxis of venereal diseases, acute rheumatic fever, common carrier states, and the prevention of postoperative pulmonary infections.

This method of administering penicillin glucose mixtures has been used in more than 40 cases of various diseases where penicillin therapy was indicated. The clinical and bacteriological response to treatment has been excellent. Patients prefer this type of treatment to injections or aerosol. By the incorporation of from 2 to 5 mg. of Benadryl/dose of penicillin glucose mixture (200 mg.) there have been no local sensitivity reactions to penicillin in the last 35 cases.

This preliminary report is presented for the purpose of stimulating further study of the method described. Several studies of the suggested applications of the method are in progress at the University of Rochester School of Medicine and Dentistry by members of various departments of the University.

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A Simple Device to Increase Background Contrast in Photomicrography

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In the photography of small insects it has been considered necessary in this laboratory to find a means of intensifying the blackness of the background. A simple microscope attachment was therefore constructed to make possible the desired contrast between the photographed object and the background. This device, which is essentially the physicists' "black body," consists of a cavity with a small opening and with interior walls of low reflectance. The opening is placed beneath the specimen to be photographed and provides a background of very nearly zero reflectance, since the light that enters the opening is absorbed within the cavity.

To construct this cavity, it was found convenient to use the black bakelite cover of a microtessar lens container, but any cylinder of comparable dimensions and lined with a nonreflective black substance should be satisfactory. A disk of black photographic paper with a ½-inch hole cut in its center was glued over the open end to provide the small opening referred to above. This simple device will ride on the condenser lens and can be elevated into position immediately below the microscope slide holding the specimen. A felt pad attached to the bottom of the device will eliminate the possibility of scratching the condenser lens.

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[1] The writer wishes to thank R. E. Worley, of the Physics Department at this University, for his review and criticism of this paper.

With the ½-inch hole in position beneath the specimen, a deep black background is provided even when the specimen is strongly illuminated with flood lamps. Thus, in the case of predominantly "black" insects, sufficient contrast is provided between the reflective "black" of the insect and the nonreflective black of the background formed by the cavity.

As it was constructed, the device (Fig. 1) is 1½ inch in diameter and has a depth of ¾ inch. However, the use of any properly blackened box with flat, removable lids having various hole sizes will serve a similar purpose when objects of greater dimensions are to be photographed.

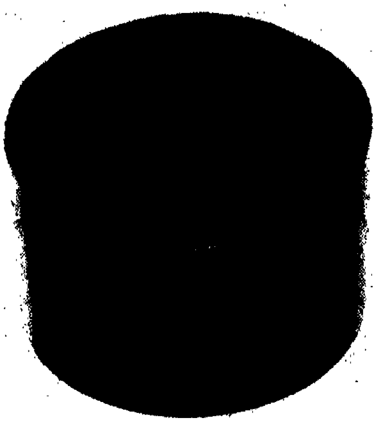

FIG. 1

Crystalline Dihydrate of Calcium Ascorbate

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Szent-Györgyi (*3*), in investigating vitamin C, mentioned that the solubility of the calcium salt excluded its identity with that of the acid studied by Bertrand and others.

Hirst, *et al.* (*1*) prepared the calcium salt by adding a slight excess of calcium carbonate to the aqueous solution of ascorbic acid. The solution was evaporated to dryness in a desiccator. The dry residue was then triturated with alcohol when a neutral salt was obtained which had a pale yellow color and gave an aqueous solution with a rotation of $[\alpha]_D^{19}$ + 91. Analysis showed a calcium content of 9.9 per cent, as compared with the theoretical 10.2 per cent, for $(C_6H_7O_6)_2$. No analysis of the carbon or hydrogen was stated, and apparently the substance was not crystalline.

Calcium ascorbate, prepared as a cream-colored dry powder, has been made in considerable quantites for medicinal preparations. However, because of its hygroscopic property, this soon took up moisture when exposed to a humid atmosphere and became gummy, decomposing to an orange-colored product. It was thus unsuitable for practical use.

One of the writers (S. L. R.) developed the stabilized solutions of calcium ascorbate which have since been widely used. Study was continued, however, to secure a stable, dry form of calcium ascorbate that could be employed for oral therapy. This has apparently been attained in the dihydrate of calcium ascorbate.

While investigating the production of a more stable form of calcium ascorbate we have succeeded in crystallizing this important salt from water. The crystals obtained are white, are much more stable than the uncrystallized salt, and have remained dry and white when exposed for several months to the humid atmosphere of the laboratory.

Due to the known tendency of ascorbic acid solutions to oxidize and undergo further decomposition, solutions of the calcium ascorbate were were not allowed to stand for long periods in water or alcohol, nor was the temperature of the solutions allowed to rise much above 30°. It was found necessary to dry the crystals with absolute alcohol and to remove the alcohol quickly to avoid oxidation of the crystals, with subsequent coloration.

METHOD

The first product to approach the crystalline salt in composition was obtained by precipitation in acetone. Sixty grams of ascorbic acid was dissolved in 140 cc. of hot water, the solution cooled to 30°, and 16.3 grams (a little less than ⅙ mole) of calcium carbonate added slowly with stirring. The solution was filtered with suction to remove a small residue and the excess of carbon dioxide. The aqueous solution was run in a thin stream by means of a pipette into 3,000 cc. of acetone with constant stirring. Some gum, in addition to a flocculent precipitate which at first was in suspension, formed on the bottom of the beaker. The gum was kneaded with the stirring rod and, on standing overnight, became brittle. This was broken up, the acetone decanted, and the precipitate washed with 300 cc. of fresh acetone. The material was filtered, ground in a mortar, rubbed up in about 200 cc. of ether to remove the excess of acetone, and filtered with suction to remove ether. When dry, it contained 9.3 per cent calcium.

One gram of the calcium ascorbate obtained by precipitation from acetone was rubbed up in 0.5 cc. of water. Crystals formed which, under the microscope, appeared as prisms.

Crystalline calcium ascorbate was next prepared from water, using as seed the first crystals obtained. One hundred and twenty grams of ascorbic acid was dissolved in 280 cc. of hot water, the solution cooled to about 25°, and 32.6 grams (a little less than ⅓ mole) of calcium carbonate added with stirring. The solution was filtered with suction, as before, to remove the small residue and excess carbon dioxide, and the filtrate was evaporated *in vacuo* to a thin syrup of about 170-cc. volume. On seeding and stirring, a crystalline mass was obtained which, after standing no longer than an hour, was filtered with suction, the crystals then being rubbed up with 200 cc. of absolute alcohol, refiltered, and washed with an additional 50 cc. of alcohol to remove excess moisture. Alcohol was removed by drawing air through the filter and then spreading the crystals on filter paper to dry. The yield was 71.9 grams, or 49.5 per cent of the theoretical. Higher yields were obtained when the solution was evaporated to a thicker syrup.

The crystals remained white and dry for months on exposure to the humid atmosphere of the laboratory.

The analysis of these crystals indicates a calcium ascorbate dihydrate.

	FOUND	CALCULATED FOR $(C_6H_7O_6)_2Ca2H_2O$
Calcium	9.42	9.40
Carbon	33.48	33.81
Hydrogen	4.24	4.25

Titration of 0.4000 gram of the calcium ascorbate in 100 cc. of N/1 acetic acid solution required 37.34 cc. of N/10 iodine, giving a value of 82.15 per cent ascorbic acid (theory for the dihydrate, 82.63 per cent).

From the above analysis one may conclude that the calcium ascorbate is a dihydrate, although drying of 0.6447 gram of the substance in vacuum at the temperature of boiling toluene for 6 hours resulted in a loss of only 0.65 per cent. At this temperature a slight decomposition occurred, with the substance turning a light yellow color, and no higher temperature was attempted in drying the calcium ascorbate. It is well known, however, that many calcium salts are combined with water, which is difficult to remove, and this crystalline calcium ascorbate is undoubtedly such a hydrate.

The specific rotation of the crystalline calcium ascorbate obtained in water was $[\alpha]_D^{20} + 95.6$ (C2.4). That obtained by Hirst for his product was $[\alpha]_D^{18} + 91$.

A study of the crystallographic and optical properties of the dihydrate of calcium ascorbate was conducted by Wilbur G. Valentine.

The material consisted of two lots: a dry sample, and a supersaturated liquor in which crystals were forming. The problem was to determine the type of crystals, assign them to the proper system, and determine the optical properties in so far as a petrographic inspection would allow.

GENERAL RESULTS

The dry sample appears to be uniform in crystallization' The crystals, which have rather definite crystal boundaries' show no evidence of deterioration on the boundaries, even after standing for a month in contact with air. In general, they are somewhat elongated triclinic crystals, with the principal optical directions oblique to all edges between crystal faces and to the general elongation of the crystals. The faces appear to be in pairs on opposite sides of the crystals.

Crystals from the concentrated liquor were also observed. In general, those forming on the sides and bottom of the vessel were larger than those in the dry sample and did not have well-formed external faces. Optically, they behaved in the same manner as those from the dry sample and are assumed to have the same triclinic crystallization. A thin skin of crystals also formed on top of the liquid. A short examination of these crystals showed that they are quite different from the others. They are distinctly elongated, being 5 to 10 times as long as they are wide. The cross-section of the prismatic crystals appears to be square. If this is true, they are almost certainly tetragonal in crystallization. The terminations are usually simple pinacoids, but partly developed pyramids were noted in a few instances.

OPTICAL PROPERTIES

Triclinic form. In most cases the greater index vibration direction was across the crystal, and the lesser more nearly parallel to the direction of elongation. In some instances, however, this situation is reversed. Hence, the elongation of the mineral is more nearly parallel to the vibration direction of the intermediate index, β. The greatest dimension perpendicular to the elongation is closest to the vibration direction of the greatest index, γ, and the shortest dimension is most nearly parallel to the vibration direction of least index, α. Because of this orientation, the determination of α in the liquid media of low viscosity used in the inspection is least certain, but the determination of γ should be fairly accurate. The best determination of α is that it lies between 1.530 and 1.535 and is nearer 1.530; γ is very close to 1.680; β was not measured directly, but should lie at about the midpoint between the two extremes. The birefringence, γ-α, is 0.150. That this is very high is borne out by the high colors shown by the small crystals observed.

Many crystals give very poor optical figures because of small size and poor orientation. All figures are definitely biaxial. In all cases where the determination seemed definite, they are biaxial negative. A few optic axis figures were seen, and the isogyre has only a slight flexure in the diagonal position. Hence, the optical angle is nearly 90°. The isogyres and color bands are sharp, indicating very little dispersion.

Tetragonal form. The study of these crystals was not extensive enough to allow as much certainty of the results as in the case of the triclinic crystals. The vibration direction of greater index is parallel to the length of the prisms and seems to be slightly higher than 1.535. The lesser index is very close to 1.530. Hence, the birefringence falls between 0.005 and 0.010. The birefringent colors check with this determination, being low gray for most crystals. No satisfactory optical figures were seen, all being flash figures. This agrees with the interpretation that these are uniaxial crystals with the C axis in the plane of the field. From the index data, the mineral should be uniaxial negative.

OTHER DATA

The material was studied under high power with a Bausch and Lomb petrographic microscope. The mineral grains were immersed in liquid media whose indices are within 0.001 of the stated amount. The crystals of the dry sample ranged from about 0.01 to 0.05 mm. in length, and from about 0.005 to 0.03 mm. in width. The triclinic crystals from the liquor were much larger, but the tetragonal crystals were about comparable in size to the triclinic crystals from the dry sample.

X-ray diffraction studies, which were carried out by Dr. Fankuchen, showed that the material is clearly crystalline. The diagram was taken with a 57.3-mm.-radius camera with nickel-filtered copper radiation (± 1.54 A.). The spacings of the first 16 lines, shown below, are in Angstrom units:

d/n	7.20	5.73	5.38	4.82	4.67	4.19	4.05	3.92
Intensity	vs	wm	w	m	w	s	m	wm
d/n	3.72	3.49	3.27	3.15	2.99	2.95	2.79	2.71
Intensity	ms	ms	ms	m	vw	w	s	w

s = strong, m = medium, v = very, w = weak.

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Book Reviews

Nieuwe biologische Principes: Inleiding tot de Genese vàn de Voortplanting. (New biological principles: introduction to the genesis of propagation.) G. Wolda. 'S-Gravenhage: A. A. M. Stols, 1946. Pp. 178. (Illustrated.)

The author has collected a mass of data on the manner of propagation of birds in their natural habitat and claims to have recognized certain laws of propagation. Accepting their universal value, the author has undertaken an analysis of human propagation, which he deemed impossible without knowledge of the breeding habits of birds.

The reasoning of the author does not seem compelling, the language is not clear, and the choice of the material is arbitrary. The latter is, for instance, evidenced by the fact that the yearly death rate as well as the birth rate show certain optima. Nevertheless, only data concerning the birth rate are considered in his theories.

Not many readers will accept the new biological principles regarding the existence of phylogenetically old and new rhythms of propagation on the basis of the material presented in this book.

H. du Buy

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Radical surgery in advanced abdominal cancer. Alexander Brunschwig. Chicago: Univ. Chicago Press, 1947. Pp. xii + 324. (Illustrated.) $7.50.

The immediate scope of this monograph is a rather limited aspect of abdominal surgery. However, broader implications are apparent on examining the rationale which led to the dramatic operations described by Prof. Brunschwig. The author feels that in recent years there has been a tendency for methods of supportive treatment of surgical patients to advance more rapidly than surgical technique. Today, surgeons may attempt to do things which would have been ill advised prior to the development of modern methods of combating shock, infection, dehydration, and starvation.

A century ago, before the advent of general anesthesia, surgery was limited to a few operations of desperation. Modern surgery was born with the successful application of anesthetic agents. More recently, other contributions to our knowledge of pharmacology and physiology have lessened the mortality and morbidity following orthodox surgical procedures. Conservative surgeons have been reluctant to exploit their new advantage with daring measures to combat diseases which, until now, have been uniformly fatal. In the field of cancer there is desperate need for improvement of cure rates as well as prolongation of life and palliation.

The text is based upon 100 consecutive cases of advanced cancer treated in the University of Chicago Clinics. The usual standards of "operability" have been disregarded for reasons which are presented in the early chapters. A major portion of the book is devoted to clinical histories and lucid detailed descriptions of operative techniques. Photographic and diagrammatic illustrations are abundant. A section devoted to supportive treatment of the surgical patient gives an excellent summary of recent developments in preoperative, operative, and postoperative care.

The last chapter consists of statistics on the cases discussed in the book. In conclusion, Prof. Brunschwig states: "The limits of operative surgery in dealing with intra-abdominal cancer are defined not in terms of operative procedures but in terms of the extent of the neoplastic process that may be encountered."

Richard B. Berlin

Naval Medical School, Bethesda, Maryland

Scientific Book Register

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Science and Statecraft

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THE EVENTS OF THE PAST FIVE YEARS have touched the lives of us all in ways both unforeseen and strange. With few exceptions we have been drawn aside from our chosen paths into activities different in kind and purpose from those naturally congenial to us. Now, as we turn our steps once more in directions fixed upon the goals we have had to abandon for a time, each of us must look upon his experiences during the war years with a still unsatisfied desire to appraise accurately their deeper significance, in both a personal and a general sense. There are few, I dare say, who do not know of lessons which could and should be drawn from their own experiences.

There must be many who share my impression that the formation of new and intricate bonds between science and statecraft is a feature of recent history which merits particularly careful analysis. The significance of developments along these lines for the scientist and the statesman, as well as for the future of mankind, needs to be comprehended, I believe, with a thoroughness which can be achieved only through the summation of limited and imperfect contributions like the one I am about to offer.

Let me begin by emphasizing the broad use I intend to make of the term "statecraft." The word "politics" in its antique acceptation would serve as well, were it not that its current meaning would introduce a certain confusion by too insistently directing attention to the minor and often ignoble tactical devices of politicians. What I wish to discuss is, rather, the high art of guiding human affairs at the level of complexity represented by the elaborately organized modern state; and I believe that in applying the term "statecraft" to this art I can suggest both its practical nature and its high place on the scale of human activity. Statecraft, thus broadly conceived, includes the handling of both domestic and foreign affairs and, by implication, also embraces the military art. It is necessary, I fear, to dwell a little upon the latter point, since it is an American habit of mind to draw a sharp distinction, practical as well as moral, between the statesman's part and that of the soldier. We are extremely reluctant to admit the lesson of history that tensions and conflicts are the rule in international affairs as in the other affairs of men; and we are even more reluctant to accept the implications of this lesson for the statesman's role in war and peace. The Teutonic directness of Clausewitz' doctrine, asserting that war is the continuation of national policy by other means, we find repellent. As for the inverted form of this doctrine, which might be phrased to assert that "peace is the opportunity for aggression by other means," even direct observation of its practical application in our times appears to fall short of carrying conviction to the American mind. Yet any objective consideration of the nature of statecraft, whether couched in universal or in national terms, must lead to the conclusion that under the circumstances of our epoch the statesman must understand both phenomenologically and theoretically the application of military force in relation to international conflicts. It is, indeed, no accident that history often reveals the great statesman and the great general combined in a single person, since the understanding of the behavior of complex societies probably meets its most direct, if not its most fundamental, challenge under the conditions of a bitterly contested war. In any event, there can be no question that the waging of a great war brings a wide range of social phenomena under a detailed scrutiny such as would normally be foregone in times of peace and which, nevertheless, provides insights of the utmost potential value for the guidance of men's peaceful affairs. It is this connection between statecraft and the military art which has particular significance in the present context, quite apart from the more basic connections mentioned above.

At no time in history, I venture to say, has our organized knowledge been brought so fully to bear upon a single, immense human undertaking as it was during the prosecution of World War II. It is hardly necessary to review the contributions made by scientists in the various warring nations to the development of military material of extraordinary variety and effectiveness, or to repeat that the fantastic achievements of science in the fields of radar, long-range missiles, and atomic explosives spell out a profound alteration of our military capabilities. To do so would, indeed, draw attention away from other aspects of the relation between science and the military art which, to my mind, have at least equal importance and which for various reasons, good or bad, still remain in relative obscurity. While it is generally recognized that a vast effort of an intellectual order was exerted in the provision of physical means for waging war, there is as yet no adequate public realization or appreciation of the comparable effort devoted throughout

Address of the retiring vice-president, Section A, AAAS, 1942, delivered at Boston, December 27, 1946.

the war to the planning and execution of military operations of every kind. Whatever appeared to be of relevance in earth science, psychology, economics, or any other branch of organized knowledge was applied for military purposes with refinements of calculation which no doubt mark a significant transformation in the military art itself. Selection and training of personnel for specialized tasks, choice and adaptation of the means to be employed under the most varied circumstances, development of tactics appropriate to the shifting realities of combat, designation of objectives at both tactical and strategic levels, analysis of the actual performance of men and of material under field conditions, and evaluation of the results achieved in specific operations were all undertaken to a surprising extent in the scientific spirit and with an extremely intelligent use of the resources of organized knowledge. In the domain of grand strategy the nature of total war manifested itself in the urgent need at all times for accurate current estimates of the total state—economic, political, psychological, and military—of each hostile power, and in the equal need for continually revised calculations of the optimum application of forces designed to encompass its eventual surrender. It is probable that no more serious or intensive attempt to arrive at a total evaluation of the dynamic state of a complex social organism has ever been made than was done under the compulsion of military necessity. It would be too much to claim that the applications made of organized knowledge were perfectly adequate to all the demands made upon it for military purposes. On the contrary, anyone familiar with one segment or another of the facts could cite many instances where relevant knowledge was overlooked, inefficiently applied, or deliberately ignored, and equally many where the imperfect state of our knowledge was clearly revealed in the light of specific military requirements.

To dwell upon such imperfections here would be both unnecessary and somewhat misleading. It is far more important to emphasize an extremely significant aspect of the rational approach to military problems which I have attempted to describe in the preceding remarks. I refer to the fact that by its very essence military planning constantly involves predictions which are subject to the immediate test of the battlefield. The ultimate penalty for error is disaster and defeat. In consequence, accuracy of observation, closeness of reasoning, and care in execution stand at a high premium in the military sphere. For all those branches of knowledge which have become allied to the military art during the recent war, this has profound implications.

It has often been observed that war accelerates and intensifies the development of new devices and new methods to an extent difficult to attain under the conditions of peace. I believe that something of the sort has occurred during the recent war with regard to the applications of science and scientific method to the problems of statecraft. In so far as those problems are of a military nature, there can be no question that the war did open up new possibilities and did afford us valuable experience in exploiting them. I have little doubt that the lessons of that experience have, at least potentially, direct significance for some of the problems of peace.

For example, the development of territories still in a wild or partly wild state, like Alaska, the Amazon Basin, or portions of Siberia, is the proper concern of statesmen and under modern conditions must apparently be contemplated in a spirit somewhat different from that which animated the explorers and pioneers of earlier generations. It seems to me reasonably clear that successful colonizing operations require organization and preparation along lines not too different from those followed by our armies in order to establish themselves in the wilderness of New Guinea. Colonization resembles a military venture even with respect to the swiftness of the retribution which may overtake erroneous appraisals of the obstacles to be mastered, as history clearly shows. A second illustration of an entirely different kind is to be found on the border line between economics and engineering, where it is becoming evident that we need a considerably improved understanding, at a strictly technical level, of the whole process of production in an industrialized society. The war confronted us with at least two major problems which made extremely heavy demands upon our knowledge in this domain: that of managing our own productive processes with maximal efficiency in relation to our total wartime requirements, and that of throttling those of our enemies in the most effective possible way with the means at our disposal, especially by strategic bombing and by submarine warfare. I believe that the experience gained in working with these wartime problems, with their definitely military character, can be used to guide our study of production under peacetime conditions for peacetime needs. If the time should ever come when it will be possible to predict with accuracy the effect upon production of variations imposed at specified points of the productive network, some of the most serious uncertainties which now confront the statesman would be removed. Some new steps in this direction can reasonably be expected in the years to come.

Leaving aside any impetus originating in the experiences of the war, I should like to suggest that there are inherent reasons why modern statecraft must move in the direction of a more scientific technique. As the integration of our great industrial societies becomes progressively tighter and their productive potentials ever greater, the acts of the statesman tend to have ever wider, deeper, and more decisive influences upon the course of events. The effects of such acts are propagated more rapidly to all parts of the social structure and are likely to be felt by the individual member of society as something of greater and more direct personal importance than was the case under older and looser forms of organization. In these circumstances it is inevitable that the statesman should calculate with increasing care the probable consequences of his acts, and that he should thus find himself forced into the position of requiring the aid of theories enabling him to predict as closely as possible the results which will flow from any course of action he may propose or adopt. Like the soldier, he realizes that his decisions may lead not merely to some form of personal failure but also to a disaster involving the entire society which he serves and guides. Accordingly, he is inclined to look favorably on the means which will help him to avoid the dangers and the pitfalls which lie ahead. Such an emphasis upon prediction as an increasingly important element in statecraft inevitably links statecraft with science, for the true distinction between science and other forms of organized knowledge lies in the concern of science with the possibility of accurate prediction. In so far as the statesman attempts to organize the knowledge relevant to his particular tasks in such a manner that he will be able to forecast the trend of events with an accuracy sufficient for his needs, he adopts the scientific attitude and gives science itself new scope.

My argument has now been developed to the point where it is necessary to weigh an objection frequently raised against attempts to consider history or politics in a scientific spirit. It is alleged that human affairs are essentially unpredictable and beyond the reach of experiment, thus falling outside the scope of scientific inquiry. I would contend that the experience of the war years does, in fact, run strongly counter to this allegation. Be that as it may, there is also room for rebuttal on logical grounds. An analysis of the objection as it is usually elaborated will show that it reposes essentially upon certain misunderstandings of the nature of modern science and, in particular, of scientific method. The science which, in this objection, is declared incommensurable with the essential character of history or politics proves upon examination to be that perfectly deterministic science with unrestricted capabilities of experimentation which constituted the philosophical ideal of the 18th and 19th Centuries and which reached its most complete expression in classical physics. It is well known, if not adequally appreciated, by everyone who discusses science that since 1900 physics has been subjected to a radical revision reaching down to its most fundamental principles. As a result it has to be conceded that, in principle as well as in practice, (1) it is not possible to know at a given instant of time all the factors which will prove to be relevant to events observable at a specified subsequent instant; (2) it is necessary to place all predictions on a statistical basis, at a sacrifice of determinism of the classical variety; and (3) it is impossible to conduct an experiment in which the experimental process does not influence in some measure the phenomena to be observed, altogether contrary to the convenient fiction that the system to be observed can be absolutely isolated from the rest of the universe throughout the experimental period.

In the case of physics there were both technical and psychological reasons why concessions along these lines were difficult to make, but in other branches of science, such as biology, psychology, and meteorology, they appear to be natural and obvious. Thus, it seems to me that, except for a matter of degree, we find science proceeding in its various recognized branches along the very lines which the skeptics consider inaccessible for the scientific method as soon as its application to history or politics is suggested. I am glad to say that the illogic of the skeptical position is beginning to be appreciated by workers in the field of social studies. As an instance, I might cite the lengthy discussion offered by Morgenthau under the title *Scientific man vs. power politics*.

A second objection to the extension of scientific method into the domain of social thought is more clearly of psychological origin and has, accordingly, less substance. This takes the form of characterizing all existing techniques as inadequate and simultaneously rejecting all innovations as speculative or unsound. There cannot be any logical answer to an objection of this order, but it might be worth pointing out that the techniques suitable to a particular field have been developed in the course of actual investigations quite as often as by transfer from other fields. It seems to me that the social sciences will have to devise many scientific techniques of their own in addition to those which can be borrowed from the more fully developed branches of science. On this point it is instructive to examine the very interesting approach to the mathematics of competition outlined by Von Neumann and Morgenstern in their recent book, *The theory of games and economic behavior*. To my mind their contribution illustrates very significantly the possibilities of designing new methods appropriate for the theoretical treatment of social phenomena at a scientific level.

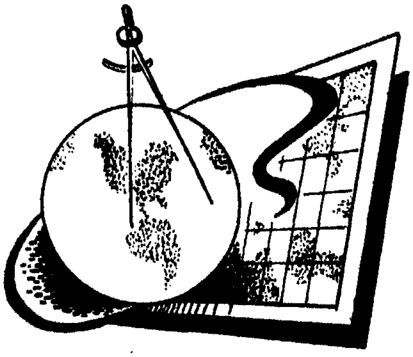
Coming to the final stage of my argument, I should like to present the hypothesis that the moment is ripe for statecraft to draw enrichment on both the practical and the theoretical sides from contact with the spirit of science, and on this hypothesis, to discuss some of the developments which seem to me to be implicit in it.

On the theoretical side I would anticipate that the demands of statecraft would greatly accelerate the introduction of scientific method into the social studies. It is quite clear, I think, that, once the social studies truly commit themselves in accord with the exigencies of our times to a serious attempt at prediction in the field of social phenomena, they will incline to loosen their ties with the fields of belles-lettres and moral philosophy—to their own considerable advantage.

On the practical side there should be greatly enlarged opportunities for the testing and revision of social and economic theories, with extremely beneficial results for both the pure and the applied branches of social science. Social scientists have certainly been at a very great disadvantage in finding themselves too generally cut off from direct experience with statecraft and deprived of the means for checking such applications as may have been made of their theoretical contributions. During recent times, when a marked modification in this state of affairs has been quite evident, many theorists have seemingly used their opportunities primarily to put their theories into practice in a reformist and somewhat doctrinaire spirit, without any real interest in the actual as opposed to the fancied consequences of so doing. If I am right in thinking that the potentialities of disaster are slowly forcing statesmen to a much more careful reckoning of the consequences of their acts, then I would anticipate that in the future both theory and practice in the social studies would assume a character considerably more objective than this and more nearly consonant with their claims to rank as branches of science. I would expect that this practical influence would prove more potent than any purely philosophical arguments concerning the essentially scientific nature of the social studies; in referring to it earlier in its military aspects and in now mentioning it again, I stress the likelihood that this influence will indeed be a profound one.

The problem of matching theory and practice is difficult, even in the fields of physics and engineering, and becomes formidably so in the domain of statecraft. In general, this problem has been badly neglected in the past, apparently on the assumption that any clearly stated theory would somehow be reduced by practical men to practical utility without the intervention of any agency specifically designed to facilitate and accelerate the process. During the war, however, a great deal of experience in the conduct of highly technical military operations has shown that a rapid adjustment between theory and practice, such as was desperately needed in many situations, can best be attained by organizing teams to work specifically and directly with this kind of problem. Something of the same kind must be done, I think, in the domain of statecraft, if theory and practice are to be brought successfully together. At best, scientific theories uniformly present a rather fragmentary and somewhat idealized synthesis which provides only a more or less approximate understanding of any specific concrete problem; and this is particularly obvious in the case of the social sciences, dealing as they do with the most complex phenomena of all. It thus appears to be in the nature of things that there should be created a new art devoted to the skillful interweaving of theoretical insights with practical experience in a variety of domains, including that of statecraft.

In conclusion, I should like to mention a concrete problem upon which the scientist and the statesman have already begun to collaborate. This is the problem of understanding and controlling the impact upon society of the discoveries made in the physical and biological sciences. The recently formed Atomic Energy Commission is, no doubt, primarily intended to provide for a properly safeguarded engineering development of atomic power, but it will obviously have to consider many questions which fall within the domain of the social sciences. It seems to me important that similar attention should be given to the social effects of the many other innovations flowing in an ever-widening stream from our laboratories. Some of the proposals for a National Science Foundation contemplate the creation of a branch or section of the Foundation which should be devoted to work in the social sciences. I should like to suggest that such a branch could most fruitfully concentrate its attention and resources upon the problems to which I have just alluded. It seems clear that successful scientific work on this problem is not beyond our present capabilities and would go a long way toward laying the foundations for that broad and intimate union of science and statecraft which, in my opinion, must ultimately be formed.



Effects of an Antibiotic From *Aspergillus fumigatus* Fresenius on Tumor Cells *in Vitro*, and Its Possible Identity With Gliotoxin

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IN SPITE OF THE DIFFICULTIES NOW INherent in the supposition that a chemotherapeutic agent can be found which will act against cancer cells without harming their normal prototypes, much research has been directed toward this end in recent times. Detailed studies already completed in this laboratory have made it plain that the growth of Brown-Pearce rabbit carcinoma cells can be suppressed under a variety of experimental conditions by an antibody that reacts specifically with a distinctive constituent of the tumor cells but not with similar constituents of other rabbit cells, either normal or neoplastic (*5*, *6*). Subsequent work extending over a period of several years has shown that a mold, isolated originally from the air of an animal room and later identified as *Aspergillus fumigatus* Fresenius, provides culture filtrates that will regularly render the cells of various animal tumors incapable of further proliferation upon brief contact with them *in vitro*. Recently a crystalline substance identical with, or similar to, gliotoxin[2] has been isolated from the culture filtrates. Both this material and purified gliotoxin procured from another source have likewise proved highly active against tumor cells *in vitro*.

EFFECTS OF CULTURE FILTRATES ON THE CELLS OF VARIOUS ANIMAL TUMORS

Following growth of the mold (designated A21 in our laboratory) on the surface of a modified Czapek-Dox medium in Blake bottles for 7–12 days at 28°–30°C., the culture liquids, which generally have a pH in the neighborhood of 3.5–4.5, are filtered through paper and stored in the refrigerator. To test for effects upon tumor cells, the culture filtrates are brought to a pH of 7.4 with NaOH, appropriately diluted with buffered Ringer's solution (pH 7.4) containing 250 mg. per cent of glucose, and incubated 2 hours at 37°C. with suspensions in the same medium of one or another of three types of tumor cells—a lymphosarcoma of C_3H mice (Gardner tumor), a sarcoma (RSI), and the Brown-Pearce carcinoma of rabbits.

Dilutions of the culture filtrates from 1:10 to 1:80 have usually prevented entirely the growth of the tumor cells upon implantation of the mixtures in suitable situations in susceptible hosts following the 2-hour sojourn *in vitro*; under these circumstances, dilutions of 1:160 and more have often affected the cells so that only small growths resulted, while control suspensions of the tumor cells in buffered glucose-Ringer's, incubated concurrently, have always given rise to large growths when implanted in corresponding situations in the same test animals. Later experiments have shown that incubation *in vitro* is unnecessary, the tumor cells being inhibited by a few minutes contact with potent culture filtrates at room temperature. The presence of broth or of serum has not diminished the tumor-inhibiting potency of culture filtrates.

Another strain of *A. fumigatus* Fresenius, procured from a different source and designated HA in our laboratory, although resembling A21 in appearance and being somewhat similar to it in cultural characteristics, has provided culture filtrates with comparatively little or no activity against tumor cells; the same has proved true of a variety of other molds.

CHARACTERISTICS AND EFFECTS OF AN ANTIBIOTIC SUBSTANCE ISOLATED FROM THE CULTURE FILTRATES

The A21 culture liquids have retained their activity apparently undiminished for several months when kept in the acid state in the refrigerator. When shaken with chloroform, the tumor-inhibiting substance has gone into the organic solvent, the remaining watery solution being devoid of inhibitory ability, while the chloroform extracts, evaporated to dryness, have yielded a gummy substance (about 0.1 mg. from each cubic centimeter of the original metabolite solution) which, redissolved in a small amount of alcohol and diluted appropriately with buffered glucose-Ringer's, has been quite as potent against tumor cells as was the original material.

As a first step toward learning whether the active material produced by *A. fumigatus* Fresenius (A21) might be similar to gliotoxin, tests were made of the effects of heat upon it, for it is known that gliotoxin is remarkably unstable when heated in alkaline solution (*7*, *9*). In two experiments it was found that culture filtrates having pH levels of 3.58 and 3.64, respectively, placed in a boiling water bath for 10 minutes and brought to pH 7.8 after cooling, were quite as potent against Gardner lymphosarcoma cells as were unheated specimens that had been adjusted to pH 7.8 and allowed to stand meanwhile at room temperature, all being inhibitory in every dilution up to and including 1:160; the same filtrates, however, brought to pH 7.8 and then heated at 100°C. for 10 minutes, smelled strongly of hydrogen sulfide and subsequently were found to have lost all demonstrable activity against tumor cells. It is noteworthy in this relation that a similar amount of heating in an alkaline medium inactivated the gliotoxin or gliotoxin-like compound produced by the strain of *A. fumigatus* employed by Menzel, Wintersteiner, and Hoogerheide (*7*).

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[1] These investigations have been aided by a grant from the Jane Coffin Childs Memorial Fund for Medical Research. It is a pleasure to acknowledge the able assistance of Miss Rose Robbins in the work.

[2] Gliotoxin is a sulfur-containing compound for which an unusual structure and the formula $C_{13}H_{14}O_4N_2S_2$ have been suggested (*1*, *2*, *4*); it was first isolated as a product of *Gliocladium fimbriatum* by Weindling and Emerson (*9*) and is prominent among the antibiotic substances produced by molds of the genus *Aspergillus* (*3*, *7*, *8*).

A sample of purified gliotoxin prepared by Johnson, Bruce, and Dutcher in the Baker Laboratory of Chemistry, Cornell University, and made available by Prof. du Vigneaud, was next tested for activity against tumor cells. In all concentrations of 1.0 μg./ml. and greater, this completely inhibited the growth of Gardner lymphosarcoma cells when incubated with them for 2 hours at 37°C.; dilutions containing 0.1 μg./ml. and less were not notably effective.

As a further step in identifying the active substance, a small amount of crystalline material was isolated from an A21 culture filtrate by the method of Menzel, Wintersteiner, and Hoogerheide (*7*); this proved indistinguishable under the microscope from the reference sample of purified gliotoxin.[3] When dissolved in buffered glucose-Ringer's solution it proved to be about as active against Brown-Pearce carcinoma cells as was the known gliotoxin, both materials in concentrations of 5 μg. and more/ml. preventing completely or almost completely the subsequent growth of the carcinoma cells held in contact with them for 2 hours at 37°C. Neither was active against these cells, however, in concentrations of 1 μg. and less/ml. Both the A21 crystalline material and the purified gliotoxin smelled strongly of hydrogen sulfide when saturated solutions of them at pH 7.4 (containing less than 200 μg./ml.) were placed in a boiling water bath for 10 minutes, and both of the heated specimens proved devoid of activity when tested subsequently against Brown-Pearce carcinoma cells.

FURTHER TESTS WITH THE ANTIOBIOTIC AND WITH VARIOUS TYPES OF CELLS

Culture filtrates having notable potency against tumor cells *in vitro* exhibited no activity against *Treponema pallidum*, *Plasmodium lophurae*, or *Trypanosoma lewisi* in a variety of similar tests, and they failed to inhibit growth in broth of a variety of microbes, including staphylococci, streptococci, pneumococci, meningococci, and *Escherichia coli*. They did not diminish the motility of human spermatozoa, as tested by John MacLeod, and had no influence on the ciliary movement of rabbit tracheal epithelium upon prolonged contact therewith *in vitro*, although the ciliary beating ceased abruptly upon contact with anisotonic solutions, fixatives, acids, and alkalis. Solutions containing large amounts of the tumor-inhibiting antibiotic did not bring about lysis of sheep's erythrocytes in 2 hours at 37°C., although they caused inflammation and necrosis in the skin and subcutaneous tissues of mice and rabbits—the effects being roughly proportional to their tumor-inhibiting potency—and they proved lethal to mice when injected in sufficient amounts.

Tumor cells of the three types employed in the present study, incubated for periods of 4–5 hours with excessive amounts of potent culture filtrates, have, upon scrutiny under the microscope, looked precisely like those incubated concurrently with buffered glucose-Ringer's solution, as repeated examinations have shown; this proved true also in the case of Brown-Pearce carcinoma cells that had undergone prolonged incubation with saturated solutions of the A21 crystalline material and of the purified gliotoxin before examination with the phase microscope by Hans Zollinger. The latter observation would seem to have added significance when contrasted with the fact, recently studied in this laboratory by Dr. Zollinger, that normal and neoplastic cells "killed" by fixatives, heat, molar NaCl, surface-active agents, etc. immediately manifest irreversible morphological changes that prove readily visible with the phase objective.

In an experiment to determine whether the activity of culture filtrates against tumor cells *in vitro* could be altered, perhaps differentially, by prior incubation with suspensions of various tissue cells, two culture filtrates were incubated 4 hours at 37°C. with suspensions of citrated mouse blood and with suspensions of washed mouse liver, spleen, kidney, and Gardner lymphosarcoma cells. The incubated mixtures were then centrifuged and the supernatant liquids tested in the usual way for activity against fresh Gardner lymphosarcoma cells. The various suspensions had not discernibly affected the more potent of the two filtrates, all of the incubated aliquots of this material inhibiting completely in the two dilutions tested (1:10 and 1:40) the subsequent growth of the fresh lymphosarcoma cells with which they were held in contact during 2 hours at 37°C. The findings were otherwise, however, with the weaker of the two filtrates. The portion incubated with the suspension of Gardner lymphosarcoma cells was devoid of activity in the test with fresh tumor cells in dilutions of 1:10 and 1:40, and those portions incubated with citrated mouse blood and with washed mouse kidney remained inhibitory in the 1:10 but not in the 1:40 dilution; the aliquots incubated with suspensions of spleen and liver cells, by contrast, had retained much, and perhaps nearly all, of their tumor-inhibiting potency, being completely inhibitory in the 1:10 dilution and almost so at 1:40, although this potency was slightly diminished when compared with that of the control aliquot that had been incubated with Ringer's solution.

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[3] The writer is indebted to Prof. du Vigneaud for advice and suggestions concerning the characterization of the crystalline material, and to Dr. Rachele for confirming the observation on the similarity of the isolated crystals and those of the purified gliotoxin. Dr. Melville generously determined the melting points on the crystalline A21 material and the sample of purified gliotoxin and also interpreted ultraviolet absorption curves on both. He reports that the micro melting points and a mixed micro melting point were not inconsistent with the possible identity of the sample of gliotoxin and that of the isolated compound, though the melting points were spread over a range of several degrees in all three cases. The ultraviolet absorption curves on both samples were quite similar to the published curves for gliotoxin.

In manometric experiments performed by Dr. William H. Summerson it was found that anaerobic glycolysis proceeded equally in mixtures containing Gardner lymphosarcoma cells and (a) crystalline A21 material in saturated solution in buffered glucose-Ringer's, (b) gliotoxin, also in saturated solution in the same medium, (c) a potent culture filtrate in a dilution of 1:10, and (d) control buffered glucose-Ringer's solution. Further tests provided evidence that oxygen consumption and glycolysis under aerobic and anaerobic conditions of Gardner lymphosarcoma and Brown-Pearce carcinoma cells were not altered by the presence of amounts of an active culture filtrate more than sufficient, as subsidiary tests proved, to prevent subsequent growth of the cells.

TESTS FOR CHEMOTHERAPEUTIC ACTIVITY

Tests for *in vivo* activity against tumor cells with whole filtrates and with chloroform extracts of them have not thus far yielded encouraging results. In one experiment, for example, a small "dose" of Gardner lymphosarcoma cells was injected intraperitoneally into five groups of C_3H mice, each containing four animals of uniform weight. Immediately afterward the mice of the control group were injected intraperitoneally with 1 ml. of buffered glucose-Ringer's solution, while each of the mice of the other four groups received 1 ml. of one or another of four potent culture filtrates that had been brought to pH 6.5–7.0, the amounts of the latter administered to each mouse being greatly in excess of what would have been required to inhibit the growth of the lymphosarcoma cells following *in vitro* contact. All of the mice developed intraperitoneal lymphosarcomata within 2 weeks, the growths appearing as promptly and growing as rapidly in the animals of the experimental groups as in the controls. In a number of other experiments, culture filtrates were administered repeatedly to C_3H mice in near-lethal doses, both before and after implantation of minimal effective numbers of lymphosarcoma cells; in no case has there been any evidence that the subsequent course of events was significantly altered by the injections. Chloroform extracts of the culture filtrates, evaporated to dryness and taken up in concentrated form in alcoholic and watery solutions, have also been administered repeatedly to mice in near-lethal amounts without influencing significantly the course of implanted lymphosarcoma cells. Toxicity tests have shown, however, that both the filtrates and the chloroform extracts contain toxic substances that produce effects distinct from those of the crystalline A21 material and of gliotoxin. Tests for *in vivo* activity against tumor cells will be undertaken with the crystalline A21 compound and with purified gliotoxin as soon as sufficient amounts of the materials can be procured.

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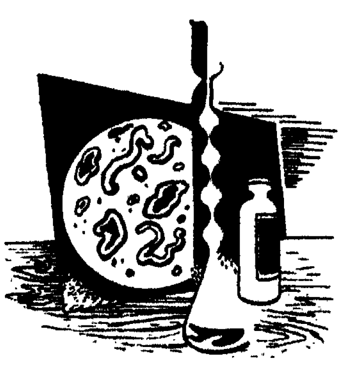

Electron Configurations of "Rare-Earth" Elements

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THE DISCOVERY OF FISSION OF URANIUM atoms by Hahn and Strassmann in 1939 has led to the most spectacular scientific developments in the world's history. Direct consequences were atomic energy release by chain reactions, culminating in the atomic bomb of 1945, and neutron sources of fantastic intensity with which it has been possible to manufacture significant amounts of new elements and isotopes. The artificial elements of greatest interest are the transuranic elements, 93 (neptunium), 94 (plutonium), 95 (americium), and 96 (curium), since both theoretical calculations and chemical speculations have been made as to the probability of 5*f*-type electrons appearing in the 7th period of the Periodic Table. The purpose of the present discussion is to review some of these suggestions and to draw attention to the spectroscopic evidence bearing on this question.

In 1926 Sugiura and Urey (*6*), from quantum-theoretical calculations of central fields based on X-ray terms, were "led to the expectation that levels corresponding to the interior 5_4 electrons should not appear before an element with atomic number 95."

In 1933 Wu and Goudsmit (*7*) calculated from Schrödinger's equation the energies of various electrons of atoms and ions built upon the radon core and concluded that "beginning with element 93 we have to consider the sixfold ionized atom to obtain the ion with the radon core and in this ion the 5*f* is certainly the lowest level. This makes it very probable that the neutral atom 93 in its normal state contains at least one 5*f* electron."

In 1941 Mayer (*3*), from calculations of the eigen functions of the 4*f* and 5*f* electrons, concluded that "the calculations for the rare-earth group agree moderately well with experimental facts. The theory would predict that the 4*f* orbits start to be filled at $Z = 61$, or $Z = 60$, at the earliest. Actually the first 4*f* electron occurs at $Z = 58$. In the neighborhood of $Z = 92$ the theory predicts occurrence of a second rare-earth group; the first filled 5*f* level should occur at $Z = 91$ or 92. Experimentally it appears that uranium does not yet possess a 5*f* electron. Inaccuracies of a few units in Z are to be expected in a calculation based on the statistical model."

Quantum theory, wave mechanics, and quantum mechanics have thus far failed to yield an accurate solution of this problem.

In 1940 McMillan and Abelson (*2*) announced the discovery of radioactive element 93 and stated that "the new element has little if any resemblance to its homologue rhenium. This fact together with the great similarity to uranium suggests that there may be a second 'rare-earth' group of similar elements starting with uranium."

In 1946 Seaborg (*5*), after reviewing the oxidation states of the transuranic elements, said that "the evidence strongly indicates that we are dealing here with a transition series of elements in which the 5*f* electron shell is being filled in a manner similar to the filling of the 4*f* electron shell in the well-known rare-earth series. Apparently this new transition series begins with actinium in the same sense that the rare-earth series begins with lanthanum, and, although the first elements in the heavy series exhibit the property of undergoing oxidation to higher states up to a maximum oxidation state of VI, the tendency in the later members of the series is to have a stable lower oxidation state, such as the III state. The most important criterion for arranging the heavy elements in this series is the probable presence of seven 5*f* electrons (analogous to the stable gadolinium structure) in tripositive curium (element 96), rather than the presence of the first 5*f* electron in thorium. In fact, there might not be any such electrons in thorium with, for example, their first appearance in protoactinium (two 5*f* electrons) or in uranium (three 5*f* electrons); and, of course, it is recognized that the 5*f* and 6*d* shells of the elements in this region lie so close together that the energy necessary for the shift from one shell to the other may in some cases be within the range of chemical binding energies. Previous to the discovery of the transuranium elements, it was almost the universal attitude that a simple filling of the 6*d* shell of electrons was taking place (*i.e.* in the elements of atomic numbers 89–92), and practically all the standard works and textbooks on chemistry and physics adopted this view. It was possible to come definitely to this other view only as a result of the study of the transuranium elements. However, it should be pointed out that a number of people have previously made the suggestion that the 5*f* electron shell begins to be filled in this region, just before or after uranium. It is beyond the scope of the present discussion to review these suggestions."

The chemical evidence proves conclusively that elements 93, 94, 95, and 96 are not homologues, respectively, of elements 75 (rhenium), 76 (osmium), 77 (iridium), and 78 (platinum), but beyond this there is no chemical proof that the heaviest elements contain 5*f* electrons except by analogy with the rare earths 58 (cerium) to 64 (gadolinium), which are known from spectroscopic (not chemical) evidence to contain 4*f* electrons. Chemists usually include 21 (scandium), 39 (yttrium), and 57 (lanthanum) in the rare earths because they exhibit similar properties (excepting spectroscopic) and oxidation states. Spectroscopists do not regard these three elements as true rare earths because they have no *f*-type electrons in their normal configurations. The valence electrons of these elements are d^1s^2 or d^2s^1. As a matter of fact, there is no direct chemical evidence for the existence of *f*-type electrons in any atoms. In the 4*f*-type rare earths (except 58 Ce) the 4*f* electrons are completely submerged in the N shell; they are inactive as valence bonds compared with the less firmly bound 5*d* electrons in the O shell or 6*s* electrons in the P shell. In the 5*f*-type rare earths the differences between binding forces on 5*f*, 6*d*, and 7*s* electrons are less, and again there is no chemical evidence for distinguishing between them. All that can be said is that, because 96 Cm in period 7 shows only tripositive valence, it may be assumed that some electrons (presumably 5*f*) are submerged and inactive, analogous to the inactive ones (4*f*) of 64 Gd in period 6. Chemical evidence, however, does not distinguish between $5f^76d^17s^2$ and $5f^66d^27s^2$, since it is well known that type 3*d*, 4*d*, and 5*d* electrons are generally also chemically inactive after their subgroups are half filled.

Spectroscopic evidence for distinguishing *d*- and *f*-type electrons is unique and unambiguous. There are two kinds of spectroscopic evidence: (1) absorption spectra of compounds in solution and (2) emission spectra of atoms or ions. The absorption spectra of certain compounds in solution are characterized by relatively narrow bands approaching in sharpness atomic spectrum lines. Such absorption bands have been reported for the elements 58 (cerium) to 70 (ytterbium), inclusive, and for 92 (uranium) but not for 21 (scandium), 39 (yttrium), 57 (lanthanum), or 90 (thorium). They have not been re-

TABLE 1

ELECTRON CONFIGURATIONS AND LOWEST TERMS OF "RARE EARTH" SPECTRA

Atomic No.	Element	Theoretical (a)		Experimental							
				Neutral atoms		Singly ionized		Doubly ionized		Trebly ionized	
		Electrons	Terms	Electrons	Terms	Electrons	Terms	Electrons	Terms	Electrons	Terms
58	Ce	$4f^1\ 5d^1\ 6s^2$	$^3H^\circ$	$(4f^2\ 6s^2)$	(^3H)	$4f^2\ 6s^1$	^4H(b)	$(4f^2)$	(^3H)(c)	$4f^1$	^2F(d)
59	Pr	$4f^2\ 5d^1\ 6s^2$	^4K	$(4f^3\ 6s^2)$	$(^4I^\circ)$	$4f^3\ 6s^1$	$^5I^\circ$(e)				
60	Nd	$4f^3\ 5d^1\ 6s^2$	$^5L^\circ$	$4f^4\ 6s^2$	^5I(f)	$4f^4\ 6s^1$	^6I(g)				
61		$4f^4\ 5d^1\ 6s^2$	^6L	$(4f^5\ 6s^2)$	$(^6H^\circ)$						
62	Sm	$4f^5\ 5d^1\ 6s^2$	$^7K^\circ$	$4f^6\ 6s^2$	^7F(h)	$4f^6\ 6s^1$	^8F(i)				
63	Eu	$4f^6\ 5d^1\ 6s^2$	^8H	$4f^7\ 6s^2$	$^8S^\circ$(j)	$4f^7\ 6s^1$	$^9S^\circ$(k)	$4f^7$	$^8S^\circ$(k)		
64	Gd	$4f^7\ 5d^1\ 6s^2$	$^9D^\circ$	$4f^7\ 5d^1\ 6s^2$	$^9D^\circ$(l)	$4f^7\ 5d^1\ 6s^1$	$^{10}D^\circ$(m)				
65	Tb	$4f^8\ 5d^1\ 6s^2$	^8H	$(4f^9\ 6s^2)$	$(^6H^\circ)$						
66	Dy	$4f^9\ 5d^1\ 6s^2$	$^7K^\circ$	$(4f^{10}\ 6s^2)$	(^5I)						
67	Ho	$4f^{10}\ 5d^1\ 6s^2$	^6L	$(4f^{11}\ 6s^2)$	$(^4I^\circ)$						
68	Er	$4f^{11}\ 5d^1\ 6s^2$	$^5L^\circ$	$(4f^{12}\ 6s^2)$	(^3H)						
69	Tm	$4f^{12}\ 5d^1\ 6s^2$	^4K	$4f^{13}\ 6s^2$	$^2F^\circ$(n)	$4f^{13}\ 6s^1$	$^3F^\circ$(n)				
70	Yb	$4f^{13}\ 5d^1\ 6s^2$	$^3H^\circ$	$4f^{14}\ 6s^2$	^1S(o)	$4f^{14}\ 6s^1$	^2S(o)				
71	Lu	$4f^{14}\ 5d^1\ 6s^2$	^2D	$4f^{14}\ 5d^1\ 6s^2$	^2D(p)	$4f^{14}\ 6s^2$	^1S(p)	$4f^{14}\ 6s$	^2S(p)		
90	Th	$6d^2\ 7s^2$	^3F	$6d^2\ 7s^2$	^3F(q)	$6d^2\ 7s^1$	^4F(r)	$6d^2$	^3F(s)	$6d^1$	^2D(t)
91	Pa	$6d^3\ 7s^2$	^4F	$(5f^2\ 6d^1\ 7s^2)$	(^4K)	$(5f^2\ 7s^2)$	(^3H)				
92	U	$6d^5\ 7s^1$	^7S	$5f^3\ 6d^1\ 7s^2$	$^5L^\circ$(u)	$5f^3\ 7s^2$	$^4I^\circ$(f)				
93	Np			$(5f^4\ 6d^1\ 7s^2)$	(^6M)	$(5f^4\ 7s^2)$	(^5I)				
94	Pu			$(5f^5\ 6d^1\ 7s^2)$	$(^7K^\circ)$	$(5f^5\ 7s^2)$	$(^6H^\circ)$				
95	Am			$(5f^6\ 6d^1\ 7s^2)$	(^8H)	$(5f^6\ 7s^2)$	(^7F)				
96	Cm			$(5f^7\ 6d^1\ 7s^2)$	$(^9D^\circ)$	$5f^7\ 7s^2$	$(^8S^\circ)$				

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ported for transuranic elements, probably because such information is at present secret. It is assumed that these bands are associated with the presence of *f*-type electrons in these ions, but this evidence is inconclusive as to the exact nature or number of the electrons involved.

The only way to distinguish the different types of electron orbits and to determine how many of each are present in an atom or ion is by way of the characteristic emission spectrum. Experimental analyses of spectral structures, supported in most cases by the Zeeman effect, have revealed the true electronic structure of atoms. Being, in general, extremely complex, the spectra of rare earths have been the last to succumb to structural analysis. Some are only partially analyzed, and others are still untouched, but sufficient information is now at hand to justify its review in connection with the question under discussion. The results are summarized in Table 1, where small letters in parentheses (a, b, c, etc.) refer to publications cited in the table and other symbols in parentheses represent extrapolations or predictions based on the analyses of neighboring spectra. The extrapolations are made on the assumption that for the production of successive ions and spectra the principal ionization always occurs by removal of the least firmly bound electron without any change or redistribution of the remaining electrons. Thus, if the normal configuration of Ce II is $4f^2 6s^1$, it is predicted that the normal configuration of Ce I will be $4f^2 6s^2$, and not $4f^1 5d^1 6s^2$. This is not a universal rule, since, for example, the normal configurations of La I and La II are found to be $5d^1 6s^2$, and $5d^2$, respectively, but it is valid for all rare-earth spectra that have been analyzed.

In 1932 Russell and Meggers (*4*) identified in La I and La II spectra excited states due to configurations involving $4f$ electrons, called attention to the fact that the terms produced by the $4f$ electrons lie lower than those arising from the $6p$ electron, and stated that this is obviously related to the fact that $4f$ electrons are bound into the normal state of the directly following elements, 58 (cerium) to 71 (lutecium), while the $6p$ electrons begin to be similarly bound only in element 81 (thallium). If my prediction for Ce is correct, the normal configuration of $5d^1 6s^2$ for 57 La becomes $4f^2 6s^2$ for 58 Ce.

Long ago the spectral analyses of 4th period elements containing $3d$ electrons revealed that an extra electron is seized by the 4th atom (24, chromium) to half fill the group and again by the 9th (29, copper) to fill it completely. Spectral analyses of 5th-period elements also proved that in atomic accretion an extra $4d$ electron is seized by the 3rd (41, columbium) and following atoms and again by the 8th (46, palladium). In the 6th period a similar tendency prematurely to half fill or wholly fill the $4f$ shell was expected, but it was not known where these accelerated accessions would begin. Spectroscopic results now available indicate that an extra $4f$ electron most likely is acquired at the very beginning (58, Ce) and again immediately after the shell is half filled (65, terbium). The $4f$ subgroup is half filled in the 6th rare earth (63, europium) and completely filled in the 13th (70, ytterbium). These facts explain the occasional divalent character of 63 Eu and 70 Yb atoms and suggest that the common compounds in which all rare earths are trivalent involve excited states ($5d^1 6s^2$ or $5d^2 6s^1$) rather than ground states (except 64 Gd and 71 Lu).

The facts concerning $5f$ electrons in the 7th period appear to be somewhat different. According to present spectroscopic information no *f*-type electrons are present in the normal states of 90 Th atoms or ions. The normal state of Th IV is ascribed to $6d^1$, that of Th III to $6d^2$ (probably), that of Th II to $6d^2 7s^1$, and that of Th I to $6d^2 7s^2$ (probably). The best-analyzed spectrum of this group is Th II, in which excited states identified with $5f$ electrons begin 4,490 cm.$^{-1}$ above the ground level, thus anticipating the binding of such electrons in the normal structures of succeeding atoms. It appears very likely that two $5f$ electrons will be found in the normal configuration of element 91 (protoactinium), because reliable analyses of the first two spectra of 92 U have proved conclusively that these atoms and ions contain three $5f$ electrons as a minimum. The ground state of U II is $5f^3 7s^2$. Levels arising from $5f^3 6d^1 7s^1$ begin at 289 cm.$^{-1}$, and those arising from $5f^3 6d^2$ begin at 4,585 cm.$^{-1}$ Other energy levels found in the U II spectrum have been identified with the electron configurations $5f^4 7s^1$, and $5f^5$. The ground state of U I is $5f^3 6d^1 7s^2$, and levels from $5f^3 6d^2 7s^1$ begin at 6,249 cm.$^{-1}$ This spectroscopic answer to the $5f$ question is positive and decisive; it was made available to the Manhattan Project on February 7, 1944, and was released to the public by Kiess, Humphreys, and Laun (*1*) on March 9, 1946. The preferred oxidation state VI of 92 U is interpreted to mean that in this case three $5f$, one (or two) $6d$, and two (or one) $6s$ electrons contribute equally to valence bonds, and the gradual shift in preferred oxidation state to III with higher atomic numbers is simply explained by the increase in stability of the $5f$ group as this shell approaches a condition of being half filled, at which point it no longer participates in the formation of chemical compounds. Although the electron configurations of transuranic elements are predicted with considerable confidence, any opportunities for testing the predictions by direct spectroscopic observation and interpretation should not be neglected.

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NEWS *and Notes*

The unexpected addition of more than 2,100 new AAAS members between January 1 and May 1, 1947, has led to a shortage of copies of some issues of *Science* in the interval. The reason for this shortage is that each new member in the first six months of the year has been sent back issues of the journal of his choice.

Back issues of *Science* lacking at the moment are Nos. 2717 and 2718 (January 24 and 31), Nos. 2719, 2720, 2721, and 2722 (all February issues), and Nos. 2724 and 2725 (March 14 and 21). Receipt of copies of these issues from members who do not maintain permanent files will be greatly appreciated. They should be sent to: American Association for the Advancement of Science, 1515 Massachusetts Avenue, N. W., Washington 5, D. C. Postage will be refunded.

The British Association for the Advancement of Science, Burlington House, London W. 1, England, will hold its first full postwar annual meeting in Dundee, Scotland, August 27–September 3, 1947, under the presidency of Sir Henry Dale. The Council of the British Association will welcome representatives of the AAAS at the Dundee meeting. The last prewar meeting of the Association, held in Cambridge in 1938, was attended by more than 60 scientists from the United States.

Each of the 15 sections of the British Association has extended an invitation to an American scientist to attend. The Council of the British Association desires to learn the names of other American scientists who will be in England at the time of the meeting.

In 1938 the British Association and the AAAS entered into an arrangement for exchange lecturers on alternate years. At the Boston meeting C. B. Fawcett, of London University, delivered a lecture under this arrangement. The British will in turn invite an American scientist to lecture at the Dundee meeting.

Heavy water and deuterium gas are now being made available by the U.S. Atomic Energy Commission for research purposes within the United States. The abundance of the heavy hydrogen isotope in the material is approximately 99.9 per cent. Quantities will be limited to normal research requirements.

The Stuart Oxygen Company, San Francisco, California, will act as contracting agent for distribution. This company began small-scale production and distribution soon after the discovery of deuterium. In the postwar period, because of the increased need for deuterium in research, the Stuart Company's production has been far below the demand. The quantities being made available are from stock produced by other operators during the war for the Manhattan District.

The material will be distributed with charges based on the cost of handling and distribution. The cost of production of the material itself will not be included. Distribution in this manner is being effected under authority of the Atomic Energy Act of 1946, which provides for the fostering and assistance of research by the Commission.

Allocation will be handled in a manner similar to that for radioisotopes. For complete information write to: U. S. Atomic Energy Commission, Research Division, Field Operations, Oak Ridge, Tennessee. Attention: Isotopes Branch.

About People

Theodore G. Bernthal, formerly associate professor of physiology, Vanderbilt University School of Medicine, is now professor and head, Department of Physiology, Medical College of the State of South Carolina, Charleston.

John S. Karling, Columbia University, has been appointed visiting professor of mycology at Louisiana State University, Baton Rouge, for the 1947 summer term.

Frank Glenn, of The New York Hospital-Cornell Medical Center, has been appointed surgeon-in-chief of the Hospital and Lewis Atterbury Stimson professor of surgery at Cornell University Medical College, succeeding George J. Heuer, who will retire on July 1.

John Q. Griffith, Jr., director, Laboratory for the Study of Hypertension, Hospital of the University of Pennsylvania, will deliver the William Hamlin Wilder Memorial Lecture of the Institute of Medicine of Chicago May 23 at the Palmer House. Dr. Griffith's subject will be "Rutin: A Therapy for the Hemorrhagic Complications of Hypertension."

Sidney Howe Yarnell, formerly chief of the Division of Horticulture, Texas Agricultural Experiment Station, will join the staff of the U. S. Regional Vegetable Breeding Laboratory, Charleston, South Carolina, on June 1 as senior geneticist.

Charles A. R. Connor, New York University College of Medicine, has been appointed associate medical director of the American Heart Association.

Morris B. Jacobs has been appointed chief organic chemist, Research Laboratories, Bureau of Laboratories, Department of Health, City of New York.

Julian S. Schwinger, Harvard University, has been appointed full professor of physics, effective July 1. With his appointment at the age of 29, Dr. Schwinger becomes one of the youngest full professors in the history of the University. Dr. Schwinger has made many important contributions to the field in his work on the scattering of neutrons by ortho- and para-hydrogen, photodisintegration of the deuteron, the theory of wave guides, and the tensor theory of nuclear forces.

H. L. Haller, organic chemist with the Department of Agriculture, has been appointed special assistant to P. N. Annand, chief of the Bureau of Entomology and Plant Quarantine of the Department. The appointment became effective March 13. With L. B. LaForge and L. E. Smith, Dr. Haller determined the chemical structure of rotenone, an important organic insecticide, for which he and Dr. LaForge received the Hillebrand Prize of the Washington Chemical Society in 1932.

Selman A. Waksman will be guest speaker at the Initiation Banquet meeting of the Connecticut Chapter of the Society of the Sigma Xi at Storrs on May 22.

William S. Heit has joined the staff of the Department of Fish and Game, Texas A & M College, to assume charge of the ornithological work of the Department.

Visitors to U. S.

A. J. Amos, British authority on cereal chemistry, will address the convention of the American Association of Cereal Chemists at the Hotel President, Kansas City, on May 19. With Dr. Kent-Jones, Dr. Amos co-authored *Modern cereal chemistry,* recognized as classical in its field. Dr. Amos is at present actively engaged in studying the chemical determination of riboflavin and nicotinic acid under a program sponsored by the Society of Public Analysts and Other Analytical Chemists.

Henri Makower, director of the Institute of Microbiology, University of Wroclaw, Poland, spent several weeks in April at the University of Texas Medical Branch, Galveston, surveying studies of Ludwik Anigstein on the chemotherapy of rickettsial diseases and of Morris Pollard on virus diseases. Dr. Makower is visiting U. S. medical centers as a guest of the Rockefeller Foundation.

Grants and Awards

Ross G. Harrison, professor emeritus, Osborn Zoological Laboratory, Yale University, was presented the John J. Carty gold medal and award for 1947 at the annual dinner of the National Academy of Sciences in Washington, D. C., April 29. Dr. Harrison received the award for his discovery that tissue cells may be grown outside the animal body, by which method he was able to demonstrate the manner of growth of nerve fibers; for his contributions as an investigator, teacher, and councilor of of students; and for his distinguished direction of the National Research Council from 1938 to June 1946.

F. A. Vening Meinesz, Dutch geodesist and geophysicist, is the recipient of the William Bowie Medal of the American Geophysical Union. The award was made at the closing session of the Union on April 30 at the Carnegie Institution of Washington, and accepted by H. Helb, of the Netherlands Embassy. Dr. Meinesz was the discoverer of a linear belt of negative gravity anomalies in the East Indies and interpreted these in relation to the structure of the earth. He has also greatly advanced the technique for observing gravitational anomalies, especially by the use of submarines.

George Howard Parker, emeritus professor of zoology, Harvard University, was elected to honorary membership in the Royal Zoological Society of Belgium on January 29.

Samuel Karlen, recent recipient of the Ph.D. degree in mathematics from Princeton University, has been appointed to the Harry Bateman Research Fellowship in pure mathematics by the Board of Trustees of California Institute of Technology. He will join the Mathematics Department of the Institute as a research fellow in September 1947.

The Bateman Fellowship, established this year by the Institute in honor of the late Harry Bateman, professor of mathematics, physics, and aeronautics, is awarded for one year but may be renewed for a second year. Dr. Karlen is the first to receive the appointment.

The California Institute of Technology, Division of Biology, has received from the Herman Frasch Foundation an annual grant of $10,000, renewable each year for a period of five years, for basic research in enzyme and protein chemistry in plant growth and development.

The Institute has conducted research in this field for the past 16 years. It will now undertake separation, isolation, and study of particular enzyme systems of higher plants, especially those having greatest interest in relation to plant growth.

The Loubat Prizes of $1,000 and $400, awarded every fifth year at the commencement exercises of Columbia University, are to be given again in 1948 for the best work printed and published in the English language on the history, geography, archaeology, ethnology, philology, or numismatics of North America. To be considered for the 1948 award, books must be published before January 1, 1948 and be submitted to the Secretary of Columbia University before February 1, 1948. The submitted material will be judged by John K. Wright, American Geographical Society; Leslie Spier, University of New Mexico; and Dexter Perkins, University of Rochester.

Northwestern University Medical School has received a gift of $50,000 from the James Foundation of New York, Inc., for use in its Institute for the Study of Rheumatic Fever, which is directed by Alvin F. Coburn. Research will be conducted in bacteriology, immunology, pathology, physiology, biochemistry, immunochemistry, enzyme chemistry, and possibly organic chemistry. In addition to fundamental research work, the Institute plans to engage in clinical research through collaboration with hospitals for the care of rheumatic children. Full-scale work will be initiated this summer.

Fellowships

The International Union of Biological Sciences invites applications for the following fellowships (1947): two at the Zoological Station, Naples, Italy; one at the Marine Biological Station, Roscoff, France; and one at the Central Bureau for the Cultivation of Fungi, Baarn, The Netherlands. These UNES-COIUBS fellowships are open to graduated students of biology in its widest sense from universities all over the world. The value of each will be $750 (U. S. currency) for students from Europe and $1,000 (U. S. currency) for students from outside Europe (travel and lodging expenses included.) Applications, stating qualifications and experience and giving full information concerning the researches to be made, accompanied by two letters of recommendation by qualified biologists and, if available, one copy of earlier publications, should reach the Executive Committee of the International Union of Biological Sciences, ℅ Prof. Dr. M. J. Sirks, Genetisch Instituut, Huis de Wolf, Haren, Groningen, The Netherlands, before October 1, 1947.

The Graduate Division of Conservation, Vassar College, is offering two fellowships for study in basic scientific problems relative to plants in the field of conservation leading to a M.S. degree in plant science. Further details may be obtained from Edith A. Roberts, Chairman, Department of Plant Science, Vassar College, Poughkeepsie, New York.

The Institute of Neurology, Northwestern University Medical School, announces the availability of fellowships for research in neuroanatomy and neurophysiology leading to the Ph.D. degree for candidates with Bachelors' degrees who intend to pursue an academic or research career in anatomy, physiology, or neurology. Applications should be made to the Director, Institute of Neurology, Northwestern University Medical School, 303 East Chicago Avenue, Chicago 11, Illinois.

Colleges and Universities

The Ohio State University will make major changes in its Bachelor of Arts curriculum effective with the fall term. The program, which will allow almost no elective courses in the first two years of study, has been designed to give students a much broader background of general knowledge. According to Harlan Hatcher, dean of the College of Arts and Sciences, the program will require that each student acquaint himself with the methods and problems faced by the physical scientist, that special training be provided in the field of biological sciences, and that greater emphasis be placed upon the social sciences.

The Howard University Sigma Xi Club was recently installed in Washington, D. C., by Harlow Shapley, national president of Sigma Xi. The chapter has a charter membership of 18 members and two associate members. After the ceremonies, Dr. Shapley talked briefly of his recent visits to Russia and India and joined members in an informal discussion of astronomy, international relations, and the future of science.

Members of the Committee on Arrangements were: W. Montague Cogg, professor of anatomy; S. R. Cooper, professor of analytical chemistry; Walter T. Daniel, associate professor of mechanical engineering; Arthur H. Webb, instructor in bacteriology; and Herman Branson, professor of physics, chairman. Charles H. Thompson, dean of the Graduate School, represented the University.

The Bureau of Biological Research, Rutgers University, has announced that its program of studies of protein metabolism has received increased support from the University, the Quartermaster Corps of the Army, the Office of Naval Research, and some 13 industrial research laboratories.

New laboratories provided include air-conditioned animal rooms, a diet kitchen and physiological laboratories, and a large analytical laboratory. The program, under the direction of James B. Allison, of the University, investigates: the nitrogen balance indexes and, where possible, the sulfur balance indexes of proteins, polypeptides, and amino acids fed orally and intravenously to normal and protein-depleted animals; the effects of depletion and repletion in proteins on the physiological state of the animal and on the formation of plasma proteins, including antibodies to specific antigens; comparative antigenicity of proteins under a variety of experimental conditions; and the mutually dependent effects of protein depletion and endocrine imbalances on nitrogen and sulfur metabolism.

Summer Programs

A Statistical Summer Session will be held August 5–September 5 at the Virginia Polytechnic Institute, Blacksburg, under the joint sponsorship of the Institute, the University of North Carolina, University of Michigan, Iowa State College, and the Federal Bureau of Agricultural Economics. Courses will be offered for credit in: engineering statistics, statistical methods, design of animal experiments, schedule design and interview techniques for sample surveys, sampling design and analysis, mathematical theory of sampling, seminar, mathematical statistics, and experimental design. The faculty, which will be drawn chiefly from the cooperating organizations, will consist of: Rensis Likert, H. L. Lucas, Maurice G. Kendall and Frank Yates (England), George W. Snedecor, Earl E. Houseman, Raymond J. Jessen, and Boyd Harshbarger.

Inquiries regarding the session should be addressed to Boyd Harshbarger, professor of statistics, Virginia Polytechnic Institute, Blacksburg, Virginia.

Meetings

The Eastern Association of Electroencephalographers will hear three papers at its annual meeting on May 24 at the New York Hospital: "Place of Electroencephalography in the Psychiatric Hospital," W. T. Liberson; "The Electroencephalogram in Behavior Problems," Margaret Kennard; and "Electroencephalography in Psychopathic Personalities," D. J. Simons. During the morning the group will be invited to inspect the laboratories and facilities of the Hospital.

The American Heart Association, Inc., will hold its annual meeting at the Hotel President, Atlantic City, New Jersey, June 6–8, just prior to the meetings of the American Medical Association. The scientific sessions, on June 6 and 7, will be open to members of the medical profession and other interested persons.

The Engineering College Research Council will meet in Minneapolis, Minnesota, June 17–21, in connection with the American Society for Engineering Education meetings. In addition to Council affairs, there will be a symposium on "Relation of College Research Organizations to Industry," J. E. Hobson, Armour Research Foundation, presiding; a roundtable discussion on "Research in Engineering Colleges Is a National Asset," C. A. MacQuigg, vice-president, presiding; and a joint meeting with the Electrical Engineering Division of the American Society for Engineering Education which will feature papers by F. E. Terman, Stanford University; J. R. Killian, Massachusetts Institute of Technology, and J. E. Hobson.

A symposium on the biological applications of isotopes will be sponsored by the University of Wisconsin, Madison, September 10–13. The program, which has been planned to include all phases of isotope work as it applies to the fields of biochemistry, physiology, bacteriology, plant physiology, and clinical medicine, will include papers by: A. Baird Hastings, Harvard Medical School; Harold C. Urey, University of Chicago; Glenn T. Seaborg, University of California; Paul C. Aebersold, Atomic Energy Commission, Oak Ridge, Tennessee; Alfred O. Nier, University of Minnesota; C. C. Coryell, Massachusetts Institute of Technology, and Martin Kamen, Washington University; Donald C. Melville, Cornell Medical School; David B. Sprinson, Columbia University; Harland G. Wood, Western Reserve University; Konrad Bloch, University of Chicago; David M. Greenberg, University of California; I. L. Chaikoff, University of California; Joseph G. Hamilton, University of California; Byron Hall, Mayo Clinic; Saul Hertz, Massachusetts General Hospital; and W. F. Bale, University of Rochester. In addition, there will be five panel discussions on various aspects of the subject.

Reservations and additional information may be obtained from E. C. Albright, Department of Medicine, 1300 University Avenue, Madison 6, Wisconsin.

A Guidance Conference on the Measurement of Student Adjustment and Achievement, conducted by the Bureau of Psychological Services, will be held June 26–27 in Ann Arbor, Michigan, according to an announcement by the University of Michigan Institute for Human Adjustment. Leaders in the fields of psychology, education, and student personnel will present and evaluate recent researches and their practical application. Sessions of the conference will be devoted to several phases of the measurement of adjustment, the measurement of achievement, the prediction of academic success, and research problems for the future.

Those interested in attending the Conference may obtain complete information from Dr. Wilma T. Donahue, Bureau of Psychological Services, 1027 East Hurton Street, Ann Arbor, Michigan.

The National Conference on Industrial Hydraulics (formerly the Hydraulic Machinery Conference) will hold its third annual meeting October 16–17 at the Hotel Continental, Chicago. The subjects of the four half-day sessions will be: "Cavitation," "Industrial Application of Hydraulics," "Automotive Fluid Transmissions," and "Hydraulic Controls." The Conference is sponsored by Armour Research Foundation and the Graduate School of Illinois Institute of Technology, in cooperation with the Western Society of Engineers and the Chicago sections of the Society of Automotive Engineers, American Society of Civil Engineers, and the American Society of Mechanical Engineers.

Additional information may be obtained from Dr. V. L. Streeter, Armour Research Foundation, Technology Center, Chicago 16.

Elections

The Rockefeller Foundation has announced the election of the following as trustees: John Sloan Dickey, president of Dartmouth College; Robert F. Loeb, Lambert professor of medicine, Columbia University; and Henry Pitney Van Dusen, president of the faculties of Union Theological Seminary and Auburn Theological Seminary.

The Corrosion Division of the Electrochemical Society elected the following officers at its April meeting in Louisville, Kentucky: Hugh J. MacDonald, Illinois Institute of Technology, chairman; M. G. Fontana, Ohio State University, vice-chairman; and I. A. Denison, National Bureau of Standards, secretary-treasurer.

The Association of Southeastern Biologists, meeting with the Southeastern Section of the Botanical Society of America and the Southern Appalachian Botanical Club at Emory University on April 18–19, elected the following officers for 1947–48: Martin D. Young, U. S. Public Health Service, president; Samuel L. Meyer, University of Tennessee, president-elect; Howard M. Phillips, Emory University, vice-president; Elon E. Byrd, University of Georgia, secretary-treasurer; and Bruce D. Reynolds, University of Virginia, E. Ruffin Jones, Jr., University of Florida, and Frederick T. Wolf, Vanderbilt University, new members of the Executive Committee. A total of 44 papers, including 13 papers in a symposium on "Biological Stations in the Southeast," were presented during the meetings.

The 1948 meeting will be held at the University of Florida, Gainesville, April 16–17.

The American Geophysical Union, meeting in Washington, D. C., April 28–30, elected the following officers to serve for three-year terms: J. A. Fleming, Carnegie Institution of Washington, honorary president; O. E. Meinzer, Washington, D. C., president; H. U. Sverdrup, Scripps Institution of Oceanography, vice-president; and K. Hilding Beij, National Bureau of Standards, general secretary.

The new Section presidents, vice-presidents, and secretaries, respectively, also elected for three years, are as follows: Geodesy—H. W. Hemple, H. H. Hess, and Frank L. Culley; Seismology—Frank Neumann, Perry Byerly, and Florence Robertson; Meteorology—Horace R. Byers, Benjamin Holzman, and Woodrow C. Jacobs; Terrestrial Magnetism and Electricity—Irwin Roman, J. W. Joyce, and David G. Knapp; Oceanography—George F. McEwen, Edward H. Smith, and Richard H. Fleming; Volcanology—Wilbur S. Burbank, William F. Foshag, and Francis G. Wells; Hydrology—Lorenz G. Straub, F. J. Veihmeyer, and Ray K. Linsley, Jr.; Tectonophysics—M. King Hubbert, Robert Balk, and Wilbur S. Burbank.

The Southeastern Section of the American Physical Society has elected the following officers for 1947: Milton Braun, Cawtawba College, chairman; E. H. Dixon, University of Georgia, vice-chairman; Eric Rogers, University of Alabama, secretary; and H. F. Henry, University of Georgia, treasurer.

The New Orleans Academy of Sciences, at its 94th annual meeting held at Tulane University, New Orleans, Louisiana, on April 25–26, elected the following officers for 1947–48: Joseph Morris, Tulane University, president; Thomas T. Earle, Tulane University, vice-president; Walter G. Moore, Loyola University, secretary; J. Karlem Riess, Tulane University, treasurer; and Garland F. Taylor, Tulane University, curator.

The New York Pathological Society has elected Ludvig Hektoen, Pierre Masson, Peyton Rous, and Francis Carter Wood honorary members in recognition of their contributions to the science of pathology.

D. E. Jackson, professor of pharmacology, University of Cincinnati Medical College, Ohio, has been elected an honorary member of the Sociedad de la Farmacologia y Terapéutica de la Asociación Médica Argentina.

The South Carolina Academy of Science elected the following new officers for 1947 at its recent meeting in Columbia: Gilbert H. Collings, professor of agronomy and soils, Clemson College, president; J. T. Penney, University of South Carolina, vice-president; and Ralph E. Blakeley, Winthrop College, secretary-treasurer.

Recent Deaths

John Alden Loring, 76, field naturalist with the Theodore Roosevelt-Smithsonian scientific expedition to Africa in 1909 and onetime curator of animals at the New York and Denver Zoological Parks, died May 8 in Owego, New York.

Robert D. Evans, 54, consulting transmission engineer with the Westinghouse Electric Corporation since 1914, died May 8 at his home in Edgewood, Pennsylvania.

Cassius Jackson Keyser, 84, emeritus Adrain professor of mathematics at Columbia University, died May 8 at his home in New York City. Prof. Keyser had been associated with the University since 1897. The first volume of his hitherto unpublished essays, now being published by a group of his friends, was to have been presented to him on his birthday, May 15.

The AAF-National Geographic Society solar eclipse expedition (*Science*, January 3) will be complete with the arrival in Bocayuva, Brazil, of the C-54 which left National Airport, Washington, D. C., on May 10. Aboard the plane, along with newspapermen, photographers, and radiomen, were Lyman J. Briggs, chairman of the National Geographic Society's research committee; Martin A. Pomerantz, Bartol Research Foundation; and Irvine C. Gardner, National Bureau of Standards. NBC will broadcast a description of the eclipse, which will not be visible in the United States, at 8:30 A. M. (EDT) on May 20.

The American Midland Naturalist will be under the editorship of John D. Mizella, Department of Biology, University of Notre Dame, managing and associate editor of the journal since December 1946, upon the resignation of Theodor K. Just, chief curator, Department of Botany, Chicago Natural History Museum, effective with the completion of the current volume (37). Future communications in regard to manuscripts, subscriptions, exchanges, etc. should be addressed to Dr. Mizella at Notre Dame, Indiana.

The National Registry of Rare Chemicals, Armour Research Foundation, 35 West 33rd Street, Chicago 16, Illinois, lists the following wanted chemicals: trihexylamine, squalene, phytic acid, dimethyl tellurium, dimethyl cadmium, perparine, octaverin, anhydrotetronic acid, desoxyribose, ethyl boric acid, d-glucurone, angelic acid, sparassol, quercimeritrin, pellotine, cotarnine, citraconic acid, silver tetraborate, phosphopyruvic acid, and tetramethylene diisocyanate.

The British Department of Scientific & Industrial Research has appointed three new chairmen of the Department's Research Boards, as follows: Forest Products Research—Sir Edward Salisbury, director of the Royal Botanic Gardens, Kew, and secretary of the Royal Society, to succeed V. H. Blackman; Fuel Research—Engineer Vice-Adm. Sir Harold Brown, former senior supply officer, Ministry of Supply, to succeed Sir Harold Hartley; Radio Research—Sir Stanley Angwin, chairman of Cable and Wireless, Ltd., to succeed Lt. Col. Sir George Lee.

The first public atomic power exhibit will highlight the Mid-America Exposition at Cleveland, Ohio, May 22–31. The exhibit is being prepared by a group committee, which includes representatives of the Atomic Energy Commission, the Mid-America Exposition, Inc., and The Kellex Corporation, and a special committee headed by J. R. Dunning, scientific director, Columbia University.

One of the features of this exhibit will be a demonstration of "splitting" the uranium atom. For this demonstration, a special instrument is being built by the Technical Associates, Glendale, California, under the direction of J. R. Dunning. This instrument will permit detection of the energy released through an amplifier. The output from the amplifier will be fed to a 20-inch cathode-ray oscilloscope and a 5-foot fluorescent tube for visual demonstration of the "splitting" process. There will also be an illuminated panel showing the resulting chain reaction following the fission and a sound amplifier for audible demonstration. The fission chamber is being built to simulate an actual pile. Another feature will be a demonstration of atomic energy as a source of power. A special power pilot plant, based on preliminary designs of Farrington Daniels, University of Chicago, is being constructed under the technical supervision of C. R. McCullough, director of atomic power, Clinton Laboratory, Oak Ridge, Tennessee, for this purpose.

The exhibit will also include a display of atomic raw materials, as well as atomic energy research instruments, among which will be the first betatron. Supplementary to exhibits of the American Chemical Society and the American Museum of Natural History, comprising 25 panels, which give the over-all picture of the development of atomic energy from its early discovery through the ore and separation stages to its peacetime applications, there will be displays covering radioactive tracers in medical research, industrial benefits, and other pertinent facets of the subject.

A Committee on Geographical Exploration has been established within the Joint Research and Development Board of the Army and Navy. The Committee is charged with responsibility "for the continuing study of means, programs, and plans for the observation and recording of geographic information in regions not normally accessible, in order to promotive and improve the capabilities of the armed services to exploit and cope with environmental conditions wherever necessary." The field of interest of the Committee includes expeditions and field research stations for geographic studies in polar, tropical, desert, and high-altitude areas.

Members of the Secretariat of the Committee are: Sidney Paige, formerly principal geologist, North Atlantic Division, U. S. Army Engineers, executive director; Wallace W. Atwood, Jr., formerly professor of physiography, Clark University, chief of the Topographic Model Section, U. S. Office of Strategic Services, and chief of the Relief Map Division, Army Map Service, deputy director; Lt. Col. Robert B. Simpson, formerly instructor in geography, University of Rochester, and recently Assistant Military Attaché to Brazil; and Lt. Cdr. L. L. Davis, USN, recently on duty with the Chief of Naval Operations.

Make Plans for—

American Oil Chemists' Society, 38th annual meeting, May 20–22, New Orleans, Louisiana.

American Society of Mechanical Engineers, oil and gas power 19th national conference, May 21–24, Cleveland, Ohio.

New England Section, American Society of Plant Physiologists, May 23–24, University of Vermont, Burlington.

Field Conference of Pennsylvania Geologists, May 30–31 and June 1, Lehigh University, Bethlehem, Pennsylvania.

COMMENTS

by Readers

Beginning in 1926 the Prussian Academy of Sciences, Berlin, began publishing its *Nomenclator Animalium Generum et Subgenerum*, edited during its various stages by F. E. Schulze, W. Kükenthal, K. Heider, and R. Hesse. The work appeared by fascicles and continued well into Volume 5; the last part to come to the Smithsonian Library was dated January 27, 1940, and was received May 12, 1941. This part was labeled "Fünfundzwanzigste Lieferung" and took the catalogue through page 3692, ending with the genus *Zaphleges*. This would indicate that there was one more forthcoming part (Lief. 26), perhaps including addenda, to finish the work through the rest of the letter Z. The war may have prevented the publication of this final Lieferung, but I have been unable to ascertain whether or not it ever appeared. Although the *Nomenclator Zoologicus* of the Zoological Society of London, edited by S. A. Neave, appeared complete in four volumes in 1939–40 and partially supplants the German work, there are certain features of the latter that are very useful to taxonomists and editors of zoological publications in checking the availability of generic names and in running down the literature. Any information which *Science* readers, at home or abroad, can furnish regarding the availability of the final part of this publication will be appreciated. (Paul H. Oehser, *editor, U. S. National Museum, Smithsonian Institution, Washington, D. C.*)

Biochemical genetics is fast reaching its place alongside firmly established branches of the biological sciences. Spiegelman and Kamen (*Science*, December 20, 1946) add much in confirming the validity of this opinion. Their attack is not the first on the tradition-bound gene theory. In their article they credit several others with similar views, especially Sewall Wright, of the University of Chicago.

They make no mention, however, of an author whose works I wish to point out, if for no other reason than to create an awareness of their existence. In a book published in 1939 by Blakiston, entitled *The biology of the cell surface*, the late Ernest E. Just, of Howard University, attacked the gene theory on the basis that "... ectoplasmic behavior determines the cytoplasmic reactions that lie at the basis of nuclear activity in both normal and abnormal mitosis." This book contains a large amount of data and much evidence for his theory, and much of what Just says substantiates and supports the Spiegelman-Kamen theory. Many other similarities exist in Dr. Just's complete works. (James H. M. Henderson, *The George Washington Carver Foundation, Tuskegee Institute, Alabama.*)

During the course of a routine examination of littoral Octopoda from the western Atlantic in the collections of the British Museum, the undersigned discovered an animal that is apparently hermaphroditic. This specimen was referred to "*Polypus occidentalis* (Steenstrup M. S. Hoyle)" by A. L. Massy (*Zoology*, 1916, **2**, 141–175) and to "*Octopus* (*Octopus*) *rugosus* Bosc" by C. G. Robson (*A monograph of the Recent Cephalopoda*. Pt. I: *Octopodinae*. London: 1929). Both authors regarded it as a female. There can be little doubt that it is a small specimen of *Octopus vulgaris* Lamarck, in accordance with the discovery that neither "*occidentalis*" nor "*rugosus*" from the western Atlantic can be regarded as distinct species (G. E. Pickford. *Trans. Com. Acad. Arts Sci.*, 1945, **36**, 701–777). The specimen, which bears the museum number B.M. 1919. 12.30.40, was taken between tide marks on the shore of the Island of South Trinidad by the "Terra Nova" Expedition. It has a mantle length of 31 mm. A summary of its taxonomic characters is included in a report, now being prepared, on littoral Octopoda from the central and western Atlantic in the collections of the British Museum. Time did not permit as thorough an examination as might be desired, although it is hoped that this may be attempted at some later date. In the meantime the following note is offered in view of the special interest of the specimen. The writer is not aware that hermaphroditism has been observed previously in the Cephalopoda although, of course, it is well known among other groups of mollusks. Moreover, in *Sepia*, according to G. Montalenti and G. Vitagliano (*Publ. Staz. Zool. Napoli*, 1946, 20, 1–18), the development of the hectocotylus is apparently concomitant with the onset of spermatogenesis, although there is no evidence of hormonal control (H. G. Callan. *Publ. Staz. Zool. Napoli*, 1939, **18**, 15–19).

In the specimen under investigation there is absolutely no evidence of hectocotylization. All arms, with the exception of the second right, which is perfect, have been damaged at their very extreme tips but had already healed before the time of capture, and in two cases, the right first and fourth, minute regenerates are developing. It is hardly likely that damage to the extreme tip of the third left arm could have completely obscured all evidence of hectocotylization; one would suppose that the spermatophoral groove would remain, even if the ligula were lost.

Because of the absence of a hectocotylus, Massy regarded the specimen as a female. However, dissection of the mantle chamber, in an attempt to determine the size of the ovarian eggs, revealed the presence of spermatophore glands. There is no penis, but left and right oviducts are present on either side of the rectum; their connections with the male system were not examined. The male internal genitalia appear to be otherwise quite normal, and the remains of two small spermatophores in Needham's organ prove that the spermatophore glands are functional. The gonad was not examined histologically to determine whether it contained ovarian as well as testicular tissue.

The observations recorded above appear to indicate that the secondary sexual characters of Cephalopoda are not subject to hormonal control.

The writer would appreciate receiving information regarding the possible occurrence of other hermaphroditic specimens. (Grace E. Pickford, *Osborn Zoological Laboratory* and *Bingham Oceanographic Laboratory, Yale University.*)

TECHNICAL PAPERS

Properties of Adsorbed Chlorophyll

H. C. Eyster

Charles F. Kettering Foundation,
Antioch College, Yellow Springs, Ohio

Most of the investigations on chlorophyll have been done in solution in such fat solvents as ether, ethanol, methanol, acetone, etc. As such, the chlorophyll is deep green in color, shows much red fluorescence, and is rapidly decomposed by light.

In the experiment described in this preliminary report, chlorophyll in solutions of acetone and ethanol was adsorbed on charcoal (norit A), talc, fuller's earth, infusorial earth, casein, agar, gelatin, Ottawa sand, absorbent cotton, filter paper, calcium carbonate, egg albumin, cornstarch, and supercel. No attempt was made to purify the chlorophyll solution, to separate the extraction mixture into *a* and *b* components, or to remove the carotenoids.

The best method of adsorbing chlorophyll from a solution was that used by Willstätter and Stoll (*2*), who adsorbed chlorophyll onto the surface of talc from an acetone solution. The chlorophyll in dry, powdered nettle leaves was extracted in 80 per cent acetone. Talc (about 1 gram to each 50 ml. of acetone solution) and then distilled water were added to dilute the acetone to 55 per cent. Upon standing (2–15 hours) and filtering, the talc residue on the filter paper was thoroughly washed with distilled water and was observed to have a deep green color, comparable to the color of many leaves. As the talc dried, the color became much lighter, as it does in leaves as they are dried. The dried talc with a green coating of chlorophyll is quite comparable in physical appearance to the powder of dried nettle leaves.

Charcoal is very effective in adsorbing chlorophyll from a diluted solution. Although it was the most effective adsorbent of those tried, it has the disadvantage of remaining black in color. Also, chlorophyll cannot be eluted from charcoal surfaces with the ordinary solvents, such as acetone, ethanol, methanol, ether, etc. According to the author's present knowledge, pyridine is the only substance which will do so.

Talc, fuller's earth, infusorial earth, cotton, supercel, and egg albumin have proved to be quite effective adsorbents of chlorophyll in 55 per cent acetone. The egg albumin was dissolved in water and then added to acetone to make a 55 per cent aqueous solution of acetone, from which the egg albumin precipitated. Sand may be just as effective if the amount of chlorophyll is correlated with surface. Casein and gelatin are somewhat less effective and have the disadvantage of becoming hardened into a tough, brittle, plastic-like material from which there can be no easy extraction of the chlorophyll. Agar, which is about the poorest adsorbent, loses what little chlorophyll it adsorbs when the agar residue is washed to remove the acetone. Calcium carbonate, cornstarch, and filter paper are also rather poor. The frayed edges of the filter paper are much more effective.

The best adsorbents are talc, fuller's earth, infusorial earth, and adsorbent cotton. These substances, when moist with water, take on the green leaf-like color and, when dry, resemble the light green color of dried leaf powder. Furthermore, except for cotton, which was used in its usual fibrous form, they retain their powdered form. The chlorophyll in all four cases can be re-extracted as easily as it is extracted from whole leaves or from such material as finely powdered, dry nettle leaves. Of these four, talc seems to be the best.

The properties of chlorophyll adsorbed on these adsorbents are very much like those of chlorophyll in the leaf, as found by Fishman and Moyer (*1*). The adsorbed chlorophyll has a natural green color, a reddish fluorescence, an electronegative charge, and great photostability. The reddish fluorescence was observed in the dark by irradiating a suspension of chlorophyll-coated talc in distilled water with ultraviolet light from a Cenco ultraviolet light source. The fact that chlorophyll adsorbed on talc, as well as chlorophyll in living cells, displays a red fluorescence is a crucial indication that chlorophyll in its natural state is adsorbed on the surface of chloroplast material, most likely the grana.

TABLE 1

Absorption Spectra of Chlorophyll in Various Aqueous Dilutions of Acetone

Acetone (%)	Absorption bands			
	First*	Second*	Third*	Fourth*
80, 75, 70	6825-6360 (6593)	6230-6030 (6130)	5875-5675 (5775)	5435 5295 (5365)
65	6895-6365 (6630)	6260-6050 (6155)	5895-5680 (5788)	5460-5310 (5385)
60	6915-6400 (6658)	6270-6070 (6170)	5915-5705 (5810)	5480-5350 (5415)
55	6950-6425 (6688)	6290-6070 (6180)	5900-5705 (5803)	5485-5340 (5413)
50	6940-6440 (6690)	6285-6070 (6178)	5895-5690 (5793)	5500-5350 (5425)
40	6870-6445 (6658)	6280-6090 (6185)	5900-5673 (5788)	5485-5360 (5423)
20	6845-6480 (6663)	Shadow		5485-5370 (5428)
10	6810-6490 (6650)			Shadow

* Averages are in parentheses.

Another important property of adsorbed chlorophyll is the similarity of its absorption spectrum with that of chlorophyll in living leaves. A study of the absorption spectra of chlorophyll in 80, 75, 70, 65, 60, 55, 50, 40, 20, and 10 per cent acetone shows that there is a shift in the position of the absorption bands between approximately 70 and 55 per cent. The shift begins slightly above 70 per cent acetone, and continues gradually and in direct proportion to any dilution between 70 and 55 per cent, becoming complete at 55 per cent (Table 1). This characteristic seems to indicate why 55 per cent acetone is the most effective dilution from which to adsorb chlorophyll on talc or any other adsorbent.

The total shifts in the bands are: 95 A. for the first, 50 A. for the second, 27 A. for the third, and 47 A. for the fourth.

Upon successive dilutions, ethyl alcohol (95 per cent) extract of chlorophyll from fresh green corn leaves shows the same shift of the absorption bands toward the red end of the spectrum: 98 A. for the first, 52 A. for the second, 27 A. for the third, and 57 A. for the fourth. A 95 per cent ethanol extract of chlorophyll from dry nettle leaves does not show a shift in the spectrum upon dilution with water, probably because of allerimization.

The reason for the shift in the spectrum as a result of dilution with water is not known definitely, but it appears that it may be due to the adsorption of (or the chemical union with) water on the surface of the chlorophyll molecule.

The absorption spectrum of chlorophyll adsorbed on the different adsorbents moistened in water is quite similar to that of chlorophyll in 55 per cent acetone or in solutions with less percentage of acetone. There is a shift toward the red end of the spectrum, quite similar to that in living leaves. The absorption spectra of chlorophyll on dry talc and on dry cotton show no change in position of the bands as compared with that of adsorbed chlorophyll on water-moistened talc and cotton. Thus, the water which possibly originally caused the shift may be retained and may be the principal factor causing the chlorophyll to adhere to talc, cotton, or any adsorbent.

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Daily Nitrogen Urinary Excretion in People of the Working Class of Caracas

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Studies on the elimination of nitrogen and on nitrogen balances are as old as the science of nutrition. The first investigators who involved themselves in these problems had the opportunity of working with very exact methods, and many of their results fit perfectly into the science of today. The work of Boussingault (*3*), Liebig (*10*), Bidder and Schmidt (*1*), and especially Voit and his collaborators (*11*) showed the relationship between nitrogen ingestion and eliminated nitrogen. The notion of nitrogen ingestion equilibrium was established.

It is well known not only that the diet of the Venezuelan people is poor in high-protein-content foods and especially low in proteins of rich biological value (*5*), but also that total serum proteins in the popular class are low, resulting in a high incidence of hypoproteinemia (*7*), especially during pregnancy (*4*) and lactation (*6*). For this reason it seemed interesting to establish the daily urinary excretion of nitrogen, this being the most exact procedure available for determining the amount of metabolized proteins in the body. These determinations were recommended by the International Conference of Berlin in 1932 (*12*) as a very accurate measure of protein intake, although, as Bigwood (*2*) stated, it is sometimes difficult to obtain a complete sample.

For the whole group it was found that 53 per cent of the determinations were under the average value, and 85 per cent eliminated less than 11 grams of nitrogen in the urine over a period of 24 hours.

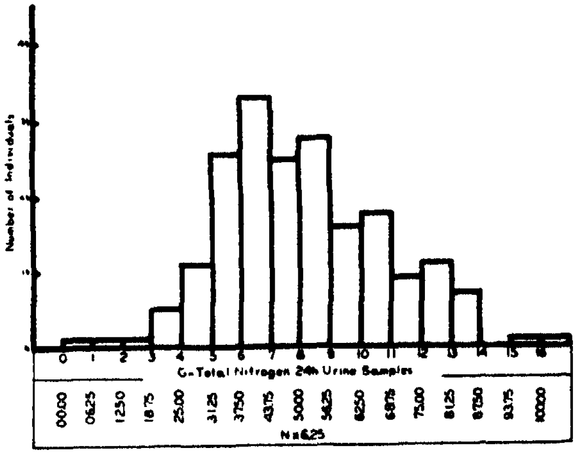

FIG. 1

Methods

Determinations were made of total nitrogen in urine eliminated over a period of 24 hours by 194 apparently healthy people attending the Health Certificate Service. Of these, 118 were females and 76 were males. The ages ranged from 11 to 57 years, but the majority were young adults. Special care was taken in order to obtain complete 24-hour samples. The subjects were notified that daily elimination is greater than one liter, and bottles for the purpose were provided. Samples suspected of being incomplete were rejected. Determinations of creatinine were made in all the samples. In a group of 37 women eliminating less than one liter of urine the average creatinine value was the same as that in a group of 92 women eliminating more than one liter. The variation coefficient was smaller in the first group. Almost all the men eliminated more than 1,000 cc. of urine.

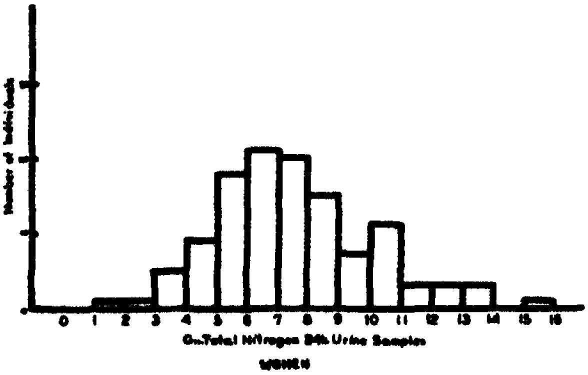

FIG. 2

The amount of urine in the samples was carefully measured. The found average for the whole group was 1.066 cc. with a S.D. 1.42. The determinations of total nitrogen were made with the macro-Kjeldahl technique (*9*), using Gunning's modification (*8*). The determinations, carried out in duplicate in 80 per cent of the cases, checked well.

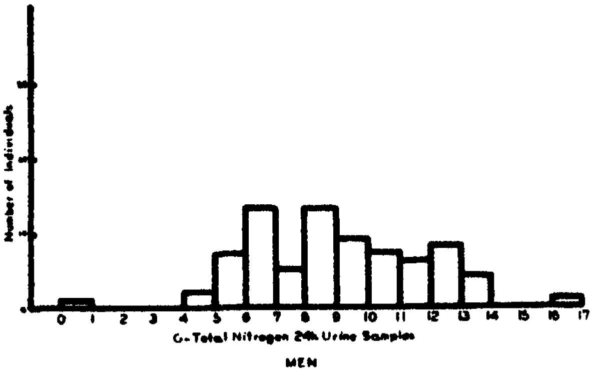

FIG. 3

RESULTS

The histograms for the whole group, the female group, and the male group are shown in Figs. 1, 2, and 3, respectively.

In Fig. 1 the values are expressed in grams of nitrogen and in calculated metabolized proteins (N × 6.25). Table 1 shows the averages, standard deviations, calculated metabolized protein corresponding to the averages, and the modes of the distributions of the found values.

TABLE 1

	No. Individuals	Averages (grams N/day)	S.D.	N × 6.25	Modes (grams N/day)
Whole group....	194	8.03	2.80	50.2	6 7
Female...	118	7.46	2.56	46.6	6-7
Male	76	8.89	2.74	55.6	6-9

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Heterologous Transplantation of Human Tumors

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Two human tumors of the same type, both questionable lymphosarcomata or leukemias, were transplanted into mice after passage through tissue culture. One animal developed a tumor which metastasized to the liver and was identical to the human tumor. Another developed a similar tumor at the site of inoculation, but the cells infiltrated the adjacent breast tissue, initiating in it an adenocarcinoma which metastasized rapidly. Another mouse presents a leukemic picture with an absolute white count of 37,000. The suspected lability of these difficult-to-diagnose lymph-node tumors is thus experimentally demonstrated. Preliminary passage through tissue culture permitted transplantation of the human tumor to the animal without previous passage through the anterior chamber of the eye.

Inhibition of Heating and Lipolysis in Seeds

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Heating and deterioration of moist seeds has constituted a problem in those processing industries where seeds must be stored in bulk for extended periods of time. Damage resulting from heating is manifested not only by visible discoloration of the seeds but also by reduction of the quantity and quality of the processed products. For example, cottonseed which has been damaged by heating during storage will yield less oil than prime cottonseed, and the oil which is obtained will contain an increased percentage of free fatty acids.

Heating in seeds during commercial storage is minimized by one of the following procedures: (1) predrying prior to storage, (2) forced aeration during storage, or (3) stacking bagged seeds in a manner that provides natural circulation of air in the interspaces. Reduction or prevention of deterioration may also be effected by treating the seeds with chemicals to inhibit the biological processes which are responsible for heating and deterioration (*1, 3, 4, 5*). An investigation has been made to determine the effectiveness of a wide variety of chemicals as such inhibitors. Preliminary results of this survey are presented here, and detailed reports on the calorimetric method used and its application to problems of seed storage will appear elsewhere.

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[1] The authors wish to acknowledge the invaluable aid given them by the many chemical manufacturers who suggested and furnished many of the compounds tested to date. The free fatty acid determinations were made by Miss Claire Lesslie.

[2] One of the laboratories of the Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, U. S. Department of Agriculture.

The test is performed by placing seeds, which have been artificially moistened and treated with the chemical whose inhibitory power it is desired to test, into calibrated Dewar flasks and drawing air through them at a rate which will support maximum heating. The temperature within the seeds is determined periodically by means of a thermocouple and manually-operated or recording potentiometer. After one week of storage under these conditions, the seeds are removed from the flasks and examined for other evidence of deterioration, e.g. content of free fatty acids in the case of oil seeds.

To compensate for differences in biological activity resulting from variations in age, history, variety, and type of sample, the response of the seeds treated with any chemical or group of chemicals is compared simultaneously with an untreated sample of the same seed having the same moisture content, and with a sample of the same seed having the same moisture content but which had been treated with a standard quantity of ethylene chlorhydrin.

Response curves obtained in a typical experiment are shown in Fig. 1. In this graph the effect of treating flaxseed conditioned to 22 per cent of moisture (wet basis) with different concentrations of diethyl oxalate is compared with the standard ethylene chlorhydrin treatment. A concentration of 0.24 per cent[1] diethyl oxalate was found to inhibit heating as effectively as 0.38 per cent ethylene chlorhydrin. It should be noted that treatment of the seed with 0.16 per cent diethyl oxalate stimulated the evolution of heat so that temperatures above that of the untreated control were observed. As will be shown (Table 1), the latter concentration of diethyl oxalate also stimulated lipolysis. The phenomenon of stimulation or inhibition as a function of concentration has been repeatedly observed in seed storage investigations (*2–4*) and appears to be an inherent property of many substances normally considered as inhibitors (*7*). After the seeds have been in the Dewar flasks for 6 days, they are removed and analyzed for free fatty acids content. The results of determination of free fatty acids corresponding to the calorimeter data in Fig. 1 are recorded in Table 1, from which it is apparent that diethyl oxalate is more effective as an inhibitor of heating than of lipolysis.

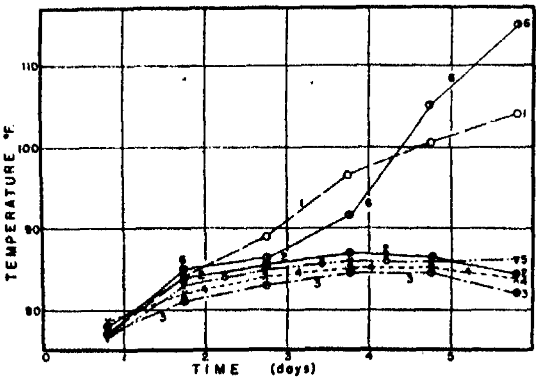

FIG. 1. Effect of ethylene chlorhydrin and diethyl oxalate on heating of moist flaxseed.

No.	Inhibitor	Concentration %
1		
2	Ethylene chlorhydrin	0.38
3	Diethyl oxalate	0.35
4	" "	0.28
5	" "	0.24
6	" "	0.16

TABLE 1

EFFECT OF TREATMENT OF MOIST FLAXSEED WITH DIETHYL OXALATE AND ETHYLENE CHLORHYDRIN ON DEVELOPMENT OF FREE FATTY ACIDS IN THE SEED OIL

Inhibitor	Concentration* (%)	Free fatty acid content† (%)
None		3.65
Ethylene chlorhydrin	0.38	0.79
Diethyl oxalate	0.35	1.05
" "	0.28	1.63
" "	0.24	2.20
" "	0.16	4.88

* Weight of inhibitor per weight of dry seed.

† Free fatty acids content of original seeds, 0.78 per cent; free fatty acids determined after storages for 6 days.

By the use of the above-illustrated method it has been possible to determine the concentration of inhibitor which will give approximately the same degree of inhibition as the standard concentration of ethylene chlorhydrin. All of the chemicals have, therefore, been tested in concentrations of approximately 0.38 per cent. Those which had less activity than ethylene chlorhydrin when applied in this concentration were rejected, while those exhibiting activity equal to or better than the

TABLE 2

RELATIVE EFFECTIVENESS OF VARIOUS CHEMICALS AS INHIBITORS OF HEATING AND LIPOLYSIS IN FLAXSEED

Chemical	Effect on lipolysis		Effect on heating	
	Concentration equivalent to 0.38% ethylene chlorhydrin (%)*	Relative effectiveness†	Concentration equivalent to 0.38% ethylene chlorhydrin (%)*	Relative effectiveness†
1-Chloro-1-nitroethane	0.42	0.9	0.42	0.9
8-Quinolinol	0.42	0.9	0.42	0.9
Orthovanillin	0.42	0.9	0.42	0.9
Phenol	0.32	1.2	0.32	1.2
Benzotrichloride	0.45	0.85	0.45	0.85
p-tert-Amyl phenol	0.42	0.9	0.42	0.9
Salicylaldehyde	0.26	1.5	0.38	1.0
1,3-Dimethyl-4,6-bis(chloromethyl)benzene	0.032	12.0	‡	‡
Ethylene brombydrin	0.18	2.1	0.18	2.1
Sodium cyanide	0.042	9.0	0.017	23.0
Propylene glycol dipropionate	0.26	1.5	0.26	1.5
Diethyl oxalate	>0.38	<1.0	0.24	1.4
Chloramine-T	<0.11	>3.5	‡	‡

* Weight of inhibitor per weight of dry seed.

† Compared to 0.38 per cent ethylene chlorhydrin as 100.

‡ These compounds did not affect the heating of the seeds in the same manner as did ethylene chlorhydrin and were, therefore, not given a relative rating.

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[1] Concentration is expressed in terms of weight of inhibitor per dry weight of treated seeds.

standard inhibitor were tested further at several other concentrations. Since there was no a priori reason to expect that the inhibitors would be equally effective on heating and lipolysis, the relative efficiency of each inhibitor was determined with respect to both effects. The comparative effectiveness of a series of chemicals is shown in Table 2.

The data reveal the fact that a wide variety of chemicals in fairly low concentrations are capable of inhibiting heating and lipolysis in moist flaxseed.[4] Although flaxseed was used in all of the experiments, a number of the inhibitors listed in Table 2 have also been used in treating moist cottonseed, rice, and grain sorghum and have been found to be equally effective. The low concentrations at which many of these compounds were effective as inhibitors of heating and lipolysis suggest their use in treating seeds on an industrial scale to improve their storage properties. Mill-scale experiments to determine the effectiveness of a number of these inhibitors are in progress.

No attempt is made here to interpret the results presented above in terms of the relation between chemical structure and biological activity of the compounds examined to date. It is probable that although their net effect, namely, inhibition of heating and lipolysis, is the same, the mechanism whereby this inhibition is achieved in the seed may differ for each inhibitor. It is necessary, therefore, to investigate their effect on the components of the enzyme systems involved in heating and lipolysis before any conclusions can be drawn regarding the relationship between chemical structure and biological activity.

Other investigators (e.g. *6*) have attributed the heating and deterioration of grain to the action of microorganisms associated with the grain. As has been pointed out in a previous publication (*4*), heating and deterioration can be equally well ascribed to the enzyme activity within the seeds themselves. It is also possible that the enzymes both in the seeds and in the microorganisms are responsible, perhaps in different degrees, for the observed biological activity of the seeds. It has not been possible to conclude definitely what relative role is played by the enzymes from the two sources.

The objective of this research has been to develop improved methods of storage of seeds intended for industrial or food utilization in which preservation of viability is not important. It is recognized that the development of improved conditions for the storage of planting stock constitutes an equally important problem, and it is hoped that some of the results of these investigations may eventually be applied in storing seeds without loss of viability.

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[4] In addition to the chemicals listed in Table 2, calcium propionate, glycol diacetate, diethyl malonate, and vinyl propionate have recently been found to act as inhibitors when used in concentrations equivalent to that of the ethylene chlorhydrin standard.

Hydrolysis by Carbitolic Caustic

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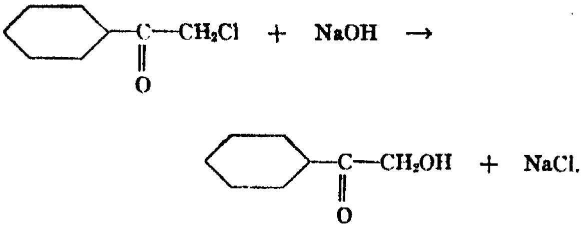
Chloracetophenone (CN) has long been a popular lacrimator both for military and civilian uses. For example, it is a standard component of grenades employed by civilian police as well as by military forces. CN is characterized by rather high chemical stability, so that decontamination of an area covered by it can be accomplished by relatively few chemical treatments. One of the favorite points of attack on the molecule is the chlorine atom through hydrolysis by alkali:



Since CN is practically insoluble in water, the hydrolysis must be accomplished by employing the caustic in a solvent which will also dissolve the CN. Such a solvent is ethanol. A solution consisting of 5 per cent of sodium hydroxide and 95 per cent of ethanol will destroy a thin film of CN on a contaminated surface in a few minutes.

Because of the fire hazard introduced by ethanol in this decontaminating agent in certain military operations, a search was made for other mutual solvents for CN and sodium hydroxide. An added requirement for the solvent was that it should have good stability toward the alkali when the solution was stored. A large number of solvents were tested, and the search finally led to the following series of compounds:

(I)	$HOCH_2CH_2OH$	Ethylene glycol
(II)	$HOCH_2CH_2OCH_2CH_3$	Cellosolve
(III)	$HOCH_2CH_2OCH_2CH_2OH$	Diethylene glycol
(IV)	$HOCH_2CH_2OCH_2CH_2OCH_2CH_3$	Carbitol
(V)	$HOCH_2CH_2OCH_2CH_2OCH_2CH_2OH$	Triethylene glycol

As a result of these tests it was found that compound IV stood out quite sharply, not only for its solvent capacity for organic compounds but also for its stability toward alkali. The solubility of CN in dry carbitol at 22° C. was found to be 28.3 grams in 100 grams of solution, and in a mixture of 21 per cent of water and 79 per cent of carbitol (by weight) it was 9.3 grams in 100 grams of solution.

A solution containing, by weight, 5 per cent sodium hydroxide, 20 per cent water, and 75 per cent carbitol hydrolyzes CN quite rapidly when in thin film on an area. (In granular form CN dissolves rather slowly in carbitol, although it dissolves to a large extent, as already stated.) Higher concentrations of caustic can be used to give more rapid hydrolysis, but concentrations over 5 per cent may cause skin injuries unless personnel are well protected. The 5 per cent caustic solution in aqueous carbitol was found to be stable for at least two years in a sealed steel drum stored in the open without cover. It turns red on standing and absorbs the oxygen from the air in the container.

The principal object of this report is to bring carbitolic caustic to the attention of laboratory workers as a possible replacement for the well-known alcoholic caustic. There are probably many circumstances under which it should be a more desirable reagent. It is relatively nonflammable and can be used at temperatures considerably higher than the boiling point of ethanol if required to decompose a compound under reflux conditions.

Changes in Urinary Steroid Excretion and Correlated Metabolic Effects During Prolonged Administration of Adrenocorticotropic Hormone in Man[1]

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Adrenocorticotropic hormone was administered to a 46-year-old male, known to have an expanding lesion involving the sella turcica which had been arrested by roentgen therapy. This subject was chosen because of the presence of signs and symptoms of moderate secondary adrenal-cortical insufficiency, which could be expected to accentuate any adrenotropic response to the pituitary hormone.

The adrenocorticotropic hormone was prepared from hog pituitary glands.[3] Two gamma of this preparation was found to give an adrenotropic response in the assay method of Sayers and Sayers (*1*). Electrophoretic analysis revealed the presence of more than one component. The material contains the equivalent of 0.12 unit of oxytocic activity/mg.; growth-promoting, gonadotropic, and thyrotropic factors are not present in significant amounts.

The patient was maintained on a constant diet and, after reaching a steady state, was given intramuscular injections of 10 mg. of A.C.T.H. every 6 hours for 6 days (40 mg. daily).

Some of the metabolic effects observed are shown in Fig. 1, in which the following changes should be noted: A 7-fold increase in the daily excretion of "11-oxysteroids," as estimated by a modification of the method of Talbot, *et al.* (*2*); an accompanying 5-fold increase in the 17-ketosteroid excretion; an increase of 58 per cent in the daily urinary output of total nitrogen, with a concurrent rise in the excretion of uric acid. Urinary creatinine remained constant from day to day. The excretion of sodium was markedly decreased throughout the period of administration.

The marked increase in the excretion of "11-oxysteroids" may be taken as definite evidence of increased adrenal-cortical activity under the action of the A.C.T.H. used. The rise in 17-ketosteroid output to as high a figure as 12.2 mg./day would indicate that the major part of this material was, in fact, derived from the adrenal cortex, since the maximum output by even normal testes is only of the order of 5 mg./day. The simultaneous changes observed in the excretion of both types of urinary steroid may be taken in support of either of two hypotheses: (1) that 17-ketosteroids derived from the adrenal cortex are formed to a considerable extent by the oxidative removal of the side chains of C_{21} steroids, the production of the latter being controlled by A.C.T.H.; or (2) that the anterior pituitary gland, through its A.C.T.H., stimulates the independent production of both C_{21} steroids and 17-ketosteroids, or related androgens, by the adrenal cortex.

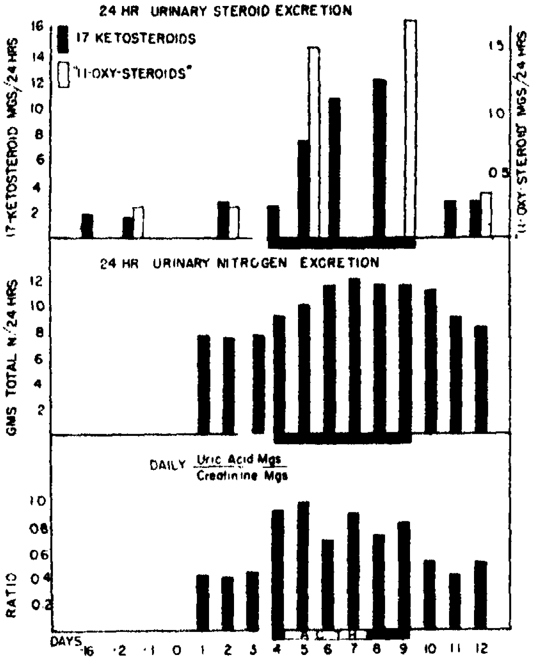

Fig. 1

The increased nitrogen excretion parallels that of the "11-oxysteroids," which are known to promote the catabolism of body protein, whereas the sodium retention suggests the elaboration of a desoxycorticosterone-like substance. From the close correlation between the observed changes in the urinary excretion of steroids, nitrogen, and uric acid, it appears useful to regard the ratio of uric acid to creatinine as a measure of increased activity of the adrenal cortex during a period of stimulation. This has been confirmed by experiments, being reported elsewhere, which include the demonstration that patients with primary adrenal-cortical insufficiency fail to show this response.

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[1] This study was aided in part by a grant from the Committee on Research in Endocrinology, National Research Council.

[2] Rockefeller Traveling Fellow.

[3] We are indebted to J. R. Mote, of the Armour Company, for a supply of the adrenocorticotropic hormone prepared in the Armour Laboratories.

IN THE LABORATORY

A Method for Measuring the Speed of Centrifuges

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The method to be described has been used to measure the speed of rotation of an air turbine.[2] It can be modified, however, to measure the speed of most rotating objects and so may be used in many instances where a tachometer or stroboscope is not readily available.

The principle is very simple and direct: A soot-covered surface is moved parallel to the axis of rotation so that each revolution is recorded; simultaneously, a record of the rate of vibration of a tuning fork is obtained on the same surface. Fig. 1 illustrates the metal frame (in this instance, brass) used to guide the movement of the sooted surface. The two vertical supports are grooved to hold a microscope slide. The horizontal support is fastened to a wooden block on each end so that the upper surface of the rotor is a short distance below the upper end of the microscope slide when it is in place in the brass frame. For recording, a fiber is glued (using speaker-cone cement) in a horizontal position on the upper surface of the rotor so that it extends ¼ inch beyond the periphery. A similar fiber is glued to the tuning fork. The choice of fibers may be varied, but a portion of a bristle from an eraser brush was found to be satisfactory for several tracings. A small length of phosphor bronze wire would be more durable. In order to reduce the deformation of the fiber, since at very high speeds there might be insufficient time for a markedly bent fiber to return to its initial position, a glass rod is sealed lengthwise to the microscope slide with De Khotinsky cement.

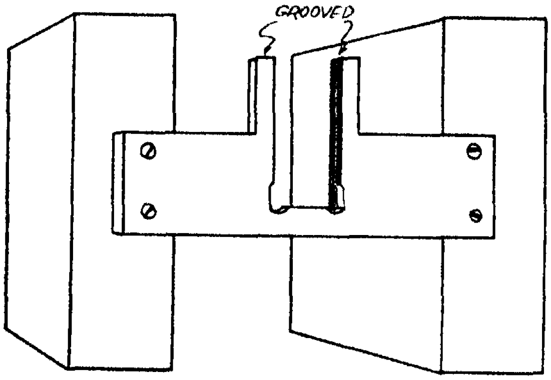

FIG. 1. Frame for holding microscope slide.

The tuning fork need not be mounted to make the measurements, although a simple support could easily be made if desired. Both surfaces of the microscope slide (including the rod) are blackened, and it is placed in the metal frame with the rod side toward the turbine. The rotor is started, and the frame is moved close enough so that the fiber just marks on the rod. The tuning fork is started and touched to the plain surface of the slide, which is pulled up out of the frame. Measurements are then made on the two sides of the slide. If one makes both measurements, starting from the marks made before the slide is moved, the tuning fork does not have to be lined up with the fiber on the rotor. No error is introduced by acceleration of the slide. If a more rapid rate of slide movement is required, the frame could easily be modified to incorporate a rubber band or spring to be substituted for hand pulling. Velocities of 300 r.p.s., using a tuning fork of 512 c.p.s., were measured easily without any conscious effort to pull the slide rapidly.

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[1] Acknowledgment is due Dr. Hans Weltin, Department of Physics, University of Oklahoma, who suggested the method and constructed the apparatus.

[2] One of the authors (F. R. H.) is indebted to the Faculty Research Fund of the University of Oklahoma for this piece of apparatus.

A Biologically Absorbable Surgical Glove Powder

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These investigations were initiated by increasing emphasis in the medical literature (*2*) that talc as a glove powder has serious limitations and that a nonirritating, biologically absorbable substitute might be indicated.

Our experience with the controlled heat denaturation of gelatin (*1*) led us to investigate the possibility of rendering gelatin flour relatively water insoluble yet amenable to *in vitro* proteolytic digestion. Such alteration of the protein molecule might yet leave it susceptible to phagocytosis and hence biologically absorbable by the tissues.

Finely ground gelatin was subjected to electric oven heating at 145° C. for the periods of time indicated in Table 1. The protein became progressively less soluble in water at room temperature. In addition to nitrogen analysis of the supernatants, a practical test of the relative tackiness of each fraction on the damp hands indicated that solubility approached a minimum after about 25 hours of heating.

TABLE 1

PROTEOLYTIC DIGESTION OF PROGRESSIVELY DENATURED GELATIN

Heating time (hrs.)	0	4	20	25	29	45	93
Pepsin digestion time (min.)	10	5	15	25	55	90	135

The *in vitro* proteolytic digestion of these heat-denatured protein fractions was ascertained as follows: A solution was prepared by dissolving 2 grams of U.S.P. pepsin in 100 cc. of 0.37 per cent HCl. To 100 mg. of the protein was added 100 ml.

of this pepsin solution, and the flask suspended with agitation in a constant temperature bath at 37° C. When by visual examination with transmitted light no solids could be seen in suspension upon vigorous agitation, the protein was considered digested. The data in Table 1 show that with prolonged dry heating (dehydration ?) of the protein powder it becomes less readily lysed by enzymatic action—a property which paralleled the physical phenomenon of decreasing water insolubility.

Gelatin powders such as those which were heated 25 hours or longer have been injected into the peritoneal cavities of rats for preliminary investigations. Animals sacrificed after 4-5 weeks showed no granulomata or adhesions; no trace of the injected gelatin powder was in evidence.

Since several of these denatured protein fractions appeared to serve satisfactorily as a rubber glove powder for lubrication, the physiological aspect of this problem is being investigated further and will be reported later in greater detail.

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A Method of Drying Partial Protein Hydrolysates and Other Hygroscopic Materials for Nutritional Studies

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Drying a protein hydrolysate by lyophilization is a procedure that often is desirable as a means of preparing diets for studies of the nutritive value of the hydrolysate. Unfortunately, the tendency to fuse during lyophilization and the hygroscopic nature of the dry material detract from the usefulness of the lyophile technique for this purpose. It has been found in this laboratory that these difficulties are overcome largely by concentrating the solution *in vacuo* and adding dextrin to the concentrated solution. Of the common dietary carbohydrates, only dextrin or starch is suitable; sucrose or cerelose does not aid in subsequent lyophilization.

The vacuum concentration of protein hydrolysates is difficult with ordinary types of distillation apparatus because of the severe foaming usually experienced. With an apparatus of the type described by Mitchell, Shildneck, and Dustin (*1*), distillation rates up to 5 l./hour may be attained at temperatures below 50°C., without any antifoaming agent. An efficient condenser is necessary. A copper water-heater coil, surrounded by a water jacket, was found to be convenient and adequate for this purpose. With this apparatus typical hydrolysates were concentrated to at least 50 per cent solids.

The concentrated hydrolysate is placed in bottles, and dextrin is added and mixed by shaking, after which shelling and lyophilizing are carried out in the usual way. The volume of hydrolysate in each bottle should not be over 10 per cent of the total volume of the bottle. In this laboratory, sufficient dextrin is added to give 30-50 per cent protein in the dry product. The lyophilized material is easily powdered for incorporation in diets.

The same procedure is useful in drying hygroscopic materials, such as liver extract, for use in experimental diets.

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Synergistic Insecticides

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During the recent war an added war had to be fought against an army of insects in order to keep our fighting men from falling prey to disease. In this connection the well-known, freon-propelled "aerosol" bomb (*3*) made its appearance. Since the end of the war the ease of handling and effectiveness of this bomb have caught the public's fancy, and it may be expected that it will be used as an additional weapon in the expanding war on insects on the home front.

Contrary to some popular misconceptions, the rapidity of knockdown action of the "aerosol" bomb on insects has been due solely to the presence of pyrethrins, which have the unique property of quickly paralyzing insects and other cold-blooded animals while being innocuous to warm-blooded animals.

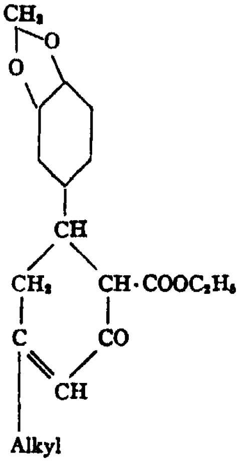
Because of the high cost of the pyrethrins, many attempts have been made to replace them, and the patent literature of the last few years describes a host of synthetic organic compounds which are highly toxic to insects. None of these, however, possesses the outstanding property of the pyrethrins.

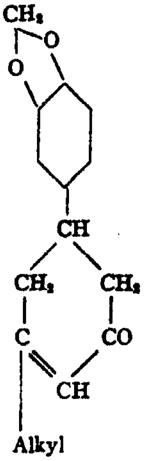
A more promising approach was initiated through the interpretation by Haller and his co-workers of the discovery by Eagleson (*1*) that the addition of sesame oil to pyrethrum extracts increased their effectiveness (*4*). These investigators linked the increased effectiveness with the synergistic effect of the sesamin present in the oil and later with the presence of a methylene-dioxy-phenyl group in the sesamin. They subsequently synthetized the amides of 3,4-methylene-dioxy cinnamic acid and found them active as synergists with pyrethrins (*2*).

These products, however, did not find practical application because of the difficulty of preparing them in quantity and because of their limited solubility in freon and in petroleum hydrocarbons, which are used as vehicles for insecticidal sprays.

O. F. Hedenburg, of the Mellon Institute, Pittsburgh, had been independently investigating compounds containing the methylene-dioxy-phenyl group as insecticides. The results with the chemicals alone did not appear too promising because of the poor knockdown property of the compounds, but when they were tested in combination with pyrethrins, a different result was obtained. While the majority of the compounds tested, including safrole and isosafrole, esters, etc., displayed little or no activity, a new product with outstanding activity was discovered. This was obtained by the condensation of the alkyl-3,4-methylene-dioxy-styryl ketones with ethyl acetoacetate (*5*). The insecticidal effect of this product is apparent from the fact that a solution of 300 mg. of this substance in combination with 30 mg. of pyrethrins in 100 cc. of odorless base oil gave 99 per cent knockdown and 90 per cent kill of houseflies when tested according to the Peet-Grady method (*8*); 30 mg. of pyrethrins dissolved in 100 cc. of odorless base oil will give a knockdown of a little better than 80 per cent and a kill of about 15 per cent; 300 mg. of the condensation product dissolved in 100 cc. of odorless base oil will, under the test conditions, give a knockdown of less than 10 per cent and therefore practically no kill.

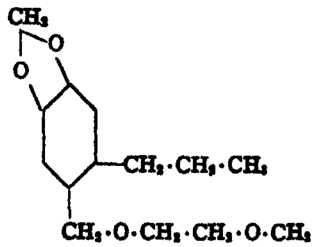
The technical reaction product found prompt commercial acceptance under the name "piperonyl cyclohexenone." It was subsequently found (*6*) to contain 80 per cent of a mixture of





in addition to higher molecular condensation products.

Although the physical characteristics of "piperonyl cyclohexenone" made it satisfactory enough to be useful in insecticidal sprays in conjunction with secondary solvents, the search was intensified for a product of increased activity and of complete miscibility with freon and with petroleum hydrocarbons. (3,4-Methylene-dioxy-6-propyl benzyl) (butyl) diethylene-glycol ether



was synthetized in this laboratory (*7*) and found to possess the desired properties. This also shared with the pyrethrins the property of being practically nontoxic to warm-blooded animals (M.L.D.: 7.5 grams/kg.). The product boils at 180° at 1 mm. It is a colorless liquid, soluble in all the common organic solvents.

The activity of piperonyl butoxide (the name given the technical product containing 80 per cent of pure compound) is indicated in Table 1. The tests were run according to the established Peet-Grady procedure (*8*) by dissolving the indicated quantities of piperonyl butoxide and pyrethrins in 100 cc. of odorless base oil.

TABLE 1

Pyrethrins (mg.)	Piperonyl butoxide (mg.)	Knockdown	Kill
20	100	93	62
20	200	96	77
20	400	97	84
30	100	95	59
30	200	97	77
30	400	99	92
40	100	97	74
40	200	98	82
40	400	97	90
40	0	84	34
100	0	95	46
0	300	8	—

While it is apparent that we still have no substitute available for pyrethrins, it is now possible to employ the latter in a very much lower concentration and to obtain effectiveness which would be uneconomical, if at all feasible, if pure pyrethrins were used. It is gratifying that the addition of the synergist does not introduce toxicological hazards.

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Specific Surfaces of Bone, Apatite, Enamel, and Dentine

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Recently a few preliminary measurements were made of the specific surfaces of some tooth and bone samples and of a synthetic hydroxylapatite.[2] In making the determination, small samples of the four powders were weighed in sample bulbs and the bulbs sealed into the vacuum system. The whole teeth were washed with distilled water and acetone and sealed in bulbs on the apparatus. The system was evacuated to approximately zero pressure and the samples heated for about two hours at 200° C. to drive off any condensed moisture or gases. After this initial operation, the adsorption determination was carried out to obtain several points on the isotherm curve. Exact details of the procedure cannot be enumerated, but many detailed procedures of gas adsorption methods are described in the literature (*1*).

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[1] Present address: Hydrocarbon Research, Inc., Trenton, New Jersey.

[2] The apatite was prepared in this laboratory (*3*). The bone was glycol-ashed rabbit bone (*2*). The dentine and enamel were samples from human teeth prepared in the powdered form by the Manly-Hodge method (*4*).

The author acknowledges the kindness of Robert C. Likins and Miss Marlene Falkenheim, of the University of Rochester School of Medicine and Dentistry, who furnished the tissue samples.

The results of the tests are given in Table 1. It was impossible to obtain exact values for the whole teeth because not a single equilibrium pressure-volume point necessary for the isotherm could be obtained during a continuous 8-hour determination. The most probable reason for the failure to obtain equilibrium points was the unusually large size of the samples.

TABLE 1

Sample	Approximate particle size	Wt. of sample (grams)	Total surface (sq. cm.)	Specific surface (sq. m./gram)
Apatite		0.0098	5,002	51.1
Dentine	60 mesh	0.0192	461.7	2.4
Enamel	60 "	0.0196	352.8	1.8
Bone ash	60 "	0.0089	8,835	99.3
Tooth #2		1.2845	22,000*	1.77*
Tooth #3		1.0528	16,700*	1.59*

* Estimation.

The surface area results on the powders are amazing. For example, bone ash has about 100 sq. m. of surface/gram. The variation of specific surface between bone, apatite, dentine, and enamel is of special interest because these were of the same particle size (*i.e.* 60 mesh). Presumably these variations revealed differences in the sizes of the submicroscopic crystals of hydroxylapatite.

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Increasing the Spreading Coefficient of Mustard Gas[1]

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It is a well-known fact that small amounts of so-called "capillary active agents," when added to water, greatly reduce the surface tension of that liquid. As a result of this phenomenon, it was assumed that the addition of a low percentage of an appropriate soluble wetting agent to mustard gas (hereafter referred to as H) would reduce its surface tension to such an extent that the interfacial tension between it and water would be reduced sufficiently to increase the spreading coefficient beyond its normal value of 1 to 4.[2] To this end, several of the commercially available wetting agents were tried. Unfortunately, however, most of these, due to their high polarity, were insoluble in H and consequently, in this investigation, Alkaterge-O[3] was used throughout in order to establish the validity of the initial premise. The mustard gas was prepared from thiodiglycol and hydrochloric acid (m.p., 14.25°; purity, 99.5%). Distilled water having a surface tension of 72.0 dynes at 26° was used.

The mathematical reasoning involved in the theory of the spreading of liquids is adequately covered in textbooks on physical chemistry (*1*).

Procedure

All measurements were made by means of the Du Nuoy interfacial tensiometer. All equipment, including the ring, was carefully cleaned in chromic acid. The ring was heated in a Bunsen flame before insertion into its seat in the apparatus. No attempt was made to control the temperature to an accuracy greater than ±1°, since the aim was to find tension differences far greater than those encountered over a 1° range in temperature. Readings were taken at room temperature of about 24°–26°. The results, averaging from about 6 to 8 separate readings, are compiled in Table 1.

TABLE 1

Surface and Interfacial Tensions of H, the System H-H_2O With and Without Alkaterge-O, and the Spreading Coefficient of H Calculated From These Values*

System	Alkaterge-O (%)	Surface tension in air, γ (dynes/cm.)	Interfacial tension (γ AB, dynes/cm.)†	Calculated spreading coefficient of H on water (γB-γA-γAB)
H_2O	0	72.0	—	—
H	0	40.6	23.0‡	+8.4§
H	½	33.2	about 6.0	+32.9
H	1	31.7	" 1.0	+39.3
H	2	31.6	" 1.0 max.	+39.4
H	5	31.4	" 1.0 max.	+39.6

* All values are corrected by means of calibration curve.

† A = surface tension of H; B = surface tension of H_2O; AB = interfacial tension of the system H-H_2O.

‡ A value of 28.4 dynes/cm. at a lower temperature is on record in an Edgewood Arsenal report.

§ A value of +1.6 has been previously recorded for a lower temperature in an Edgewood Arsenal report.

It is apparent from the data presented that the surface and interfacial tensions of H can be lowered through the addition of 1 per cent of a surface active agent such as Alkaterge-O. The lowering of the tensions is sufficient to increase the spreading coefficient considerably above the value obtained with untreated H.

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[1] Published with the permission of the Chief, Chemical Corps.

[2] Taken from reports on file at Edgewood Arsenal.

[3] An amine of high molecular weight, obtainable from the Commercial Solvents Corporation, New York City. According to the analysis performed in the Edgewood Laboratories, the empirical formula is [illegible].

World Soil and Fertilizer Resources in Relation to Food Needs

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HUNGER AND STARVATION HAVE stalked the footsteps of man since the dawn of history. Only with the bloom of modern science in the last half century has there for the first time come hope that these gaunt specters could be banished if man but willed it so. Through the centuries those in positions of leadership have been prone to accept the misery of hunger as an unavoidable fact of life, the result of population pressure on a limited food supply.

In the midst of the most destructive war in history the leaders of the Allied Nations determined that one of the goals of victory should be *freedom from want*. To some, science appears to offer a basis of fact for this ideal. Here in our own country, farmers applied the results of agricultural research so efficiently during the war years that, despite many difficulties, production of food crops reached and held an unprecedented peak. It seems reasonable that, with the peace, benefits of agricultural research may be extended still further and that all the people of the world may be better fed.

The high ideals that came with the fervor of the war are now being evaluated coolly in the light of peacetime realities. The peoples of the warring nations are determined to be practical. With skeptical minds they are asking: Is it, after all, reasonable to hope that the world can produce enough to feed all its human inhabitants? Can the world's soil grow all the crops that would be needed? Are fertilizer sources great enough? Do we have the technology and management ability to produce the crops and maintain the soils? These questions do not encompass the whole problem by any means, but these are questions I am being asked. I am glad to try to answer them, for I am convinced that we do have the soils we need, we do have the fertilizer resources, we have available the management ability, and we could produce enough food for all.

But how much is enough? We have an answer suitable for our purpose from the recent "World Food Survey" made by the Food and Agriculture Organization of the United Nations. By 1960, if everyone is to have an adequate diet, the world will need, according to the estimates of this survey, the following increases beyond prewar production: cereals, 21 per cent; roots and tubers, 27; sugar, 12; fats and oils, 34; pulses and nuts, 80; fruits and vegetables, 163; meat, 46; and milk, 100.

Considering only the natural physical resources needed to obtain these increases in food production, and with acute awareness of many other problems involved, there are two obvious courses we can follow in seeking higher food production the world over. First, and perhaps as the easier course, we could obtain much of the increase through more intensive and more efficient use of the land now farmed. Second, with our knowledge of world soil types, we could expand production in the areas having undeveloped soil resources.

Some of the possibilities of intensive and efficient production are readily evident in our own war experiences. Production of food crops was maintained at about 35 per cent above the period 1935–39. Admittedly, weather was more favorable than during the prewar years, but even with no more favorable weather the production would have been 20 per cent greater, despite the fact that the labor force was actually 6 per cent smaller.

Our experiment stations and our more successful farmers provide many illustrations of the opportunity for increasing food crop yields and animal production by applying these improved agricultural techniques more widely. Thus, the limiting factors to increased production seem to be lack of education and lack of capital rather than any limits of physical production capacity. For example, recent experiments on corn culture in the Southeast under ordinary farm conditions show that corn yields for that area can be more than doubled by a combination of improved practices. In addition to regular fertilization practices, these include heavy nitrogen treatment combined with the growing of adapted hybrids, closer spacing to take advantage of heavier fertilization, and early and shallow cultivation for weed control. By 1960 perhaps, 50-bushel-per-acre corn production in the Southeast will be the rule rather than, as today, the exception.

This and many other examples would indicate also that the estimates of production possibilities after the war, under prosperity conditions, made cooperatively by the U. S. Department of Agriculture and the land-

The information contained in this paper was presented as a part of a panel before Section O (Agriculture) at the annual meeting of the AAAS, Boston, December 30, 1946.

grant colleges, are really conservative, though they may appear somewhat optimistic. According to these estimates, by 1950 appreciable increases in production per acre of most of our principal crops over that obtained in the 1935–39 period can be readily attained. The estimated increases were as follows: corn, 31 per cent; hay, 28; wheat, 18; rice, 13; peanuts, 20; sugar beets 17; potatoes, 22; and sweet potatoes, 31.

TABLE 1

ESTIMATED ATTAINABLE INCREASE IN YIELD DUE TO IMPROVED PRACTICES

Crop		Yield	
		1935–39	1960
		USSR	
Wheat	bushels	10.0	12.0
Rye	"	12.7	13.5
Corn	"	16.3	20.0
Oats	"	22.2	28.0
Barley	"	14.9	18.0
Sugar beets	tons	6.1	8.0
Potatoes	bushels	121.5	180.0
		India	
Wheat	bushels	10.7	20.0
Rice	"	26.2	40.0
Corn	"	12.9	20.0
Barley	"	16.5	20.0
Peanuts	pounds	400.0	600.0
		China	
Wheat	bushels	14.9	18.0
Rice	"	52.5	70.0
Corn	"	24.2	35.0
Barley	"	21.8	24.0
Peanuts	pounds	769.0	1,000.0
Soybeans	bushels	16.8	20.0
Dry beans	pounds	730.0	1,000.0
Potatoes	bushels	100.0	150.0
		United States	
Corn	bushels	28.1	36.7
Oats	"	31.7	38.5
Hay	tons	1.4	1.8
Potatoes	bushels	124.0	152.0
Soybeans	"	18.5	21.9
Peanuts	pounds	765.0	916.0
Wheat	bushels	12.4	14.6
Rice	"	47.5	53.6

The United States, which alone cannot feed the hungry of the world, must look to other countries also to intensify food production, preferably in the food-deficient areas. Prior to the war, Europe, with the exception of Poland, Russia, and the Balkans, had reached a high degree of intensified farming in relation to its soil resources. Significant increases in the more highly developed European countries are thus doubtful. If, however, we take into account yield increases readily attainable in different soil regions of the United States, we can safely predict those in other countries possessing the same great soil groups. Such predictions for China, India, and the Soviet Union, the world's three most populous countries, are given in Table 1. These take into account the present reported average yields and the general intensity of present cropping practices, in so far as they are known. Yield increases considered attainable in these countries by 1960 are substantially equivalent to those considered attainable in the United States by 1950, as reported in *Peace-time adjustments in farming*, (U. S. Department of Agriculture, Miscellaneous Publ. No. 593).

It is impossible with the data available to make predictions on possible production in increases by individual crops the world over, because acreage, yield, and production of many important crops are not reported by all countries. Also, much of the world's food supply comes from animal products, and the efficiency of this production in different countries is not known. But we can estimate probable increases in world production of the principal 8 classes of food, by applying to each class the percentage increases of about the same magnitude as those thought attainable by 1950 for the principal crops in the United States. Table 2 is an estimation of the world food supply possible in 1960 as a result of more intensive and better farming methods on present cropland compared with the supply needed in 1960 to give all the people of the world an adequate diet, as estimated in the FAO survey.

TABLE 2

PREWAR FOOD PRODUCTION AND PERCENTAGE INCREASES ATTAINABLE FROM MORE INTENSIVE USE OF PRESENT CROPLAND*

	Cereals	Roots and tubers†	Sugar	Fats and oils	Pulses and nuts	Fruits and vegetables‡	Meat	Milk
Prewar production (millions of metric tons)	300.4	153.2	30.0	15.2	36.2	156.3	65.6	150.2
Increase attainable from present cropland (%)	20	50	15	20	20	35	20	20
Attainable production from present cropland (millions of tons)	360.0	230.0	34.5	18.0	43.4	211.0	78.7	180.2
World food needs in 1960 (millions of tons)	363.5	194.5	33.6	20.4	65.2	411.0	95.8	300.0

* For 70 countries including 90 per cent of world population.

† Including bananas.

‡ Including eggs and fish.

In arriving at these estimates it is necessary to assume that the total prewar world food supply equaled prewar food consumption. The figures for prewar world food supplies were therefore obtained by multiplying per capita consumption, as reported in the FAO survey, by world population. Larger percentage increases were applied to roots and tubers and to fruits and vegetables because of the apparent opportunity for greatly increasing yields of these crops by the generous use of fertilizers.

On the basis of these estimates, world food needs in 1960 could be met for sugar and for roots and tubers on existing cropland, the need for cereals could virtually be met, but production of all other classes of food would fall short of the need.

It should be borne in mind, however, that the increases assumed to be attainable on existing cropland are conservative. There seems little doubt that a general use of high rates of fertilization on soils that will respond, coupled with modern techniques of insect and disease control, a change in land use patterns, selection of the best varieties, flood and erosion control, and adoption of other lesser techniques, would result in even larger increases.

There are even greater opportunities, but more difficulties perhaps, in increasing food production by bringing new lands into cultivation. At present only 7–10 per cent of the total world land area is cultivated. Except for some desert areas, perpetual snow and ice, tundra, and the most rugged mountains, there is virtually no limit to the acreage that can be brought into cultivation, save the economic limits of costs and returns. When we consider the great soil groups of the world and the relatively small extent to which some of them are already in cultivation, these possibilities become more apparent.

Soil maps have been made of many parts of the world. During the past few years our Bureau has made serious attempts to assemble these into a series of maps of uniform nomenclature, so that various regions can be compared, and to fill in unmapped areas through careful study of climatic, geological, and other relevant data. Although this research is uncompleted, it has given soil scientists an opportunity to arrive at a few general preliminary judgments about our soil resources. A very small-scale, exceedingly generalized map of the world compiled some time ago may be useful to indicate the location of the food soil area of the world (Fig. 1).

Snow and ice, tundra, mountains, and deserts total 48 per cent of the world land areas. We can assume that these areas have no practical possibilities for extension of agriculture. The chernozem, chestnut, gray forest, podzol (including gray-brown podzolic), the red soils of the tropics and subtropics, and alluvial soils occupy an estimated 52 per cent. In this 52 per cent we can look for areas for expansion of agriculture. The chernozem and chestnut soils are now largely under cultivation, and no great expansion into new areas can be foreseen. Some reclamation of alluvial soils, either by drainage or irrigation, or both, should be possible in the tropics.

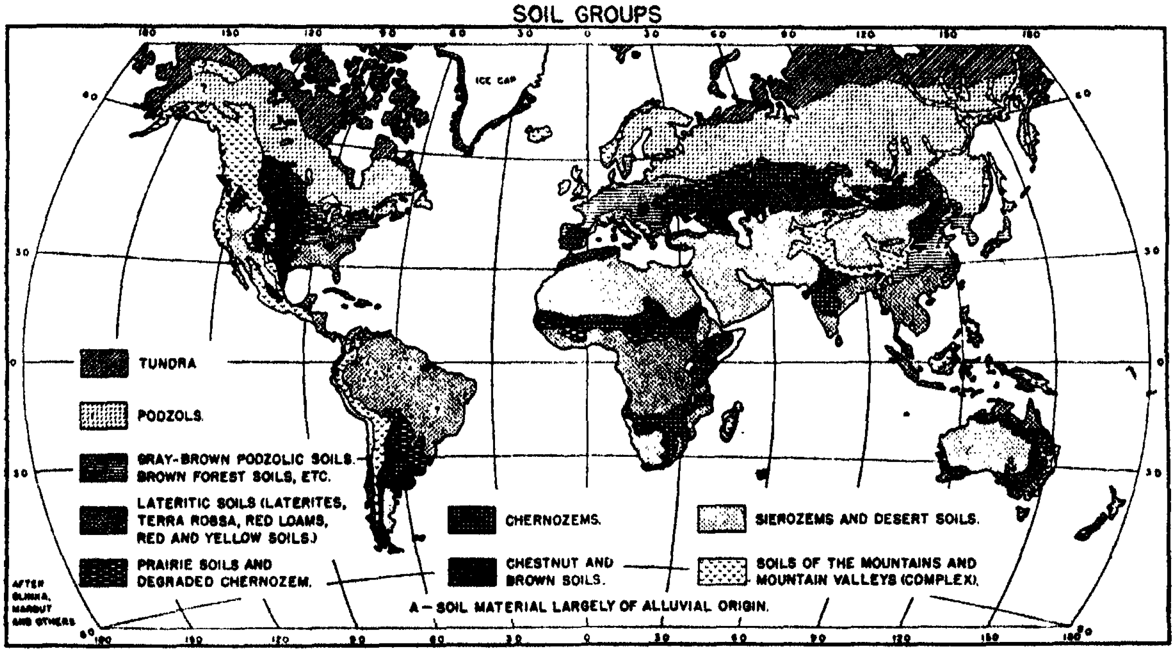

SOIL GROUPS
ICE CAP
TUNDRA
PODZOLS.
GRAY-BROWN PODZOLIC SOILS. BROWN FOREST SOILS, ETC.
LATERITIC SOILS (LATERITES, TERRA ROSSA, RED LOAMS, RED AND YELLOW SOILS.)
PRAIRIE SOILS AND DEGRADED CHERNOZEM.
CHERNOZEMS.
CHESTNUT AND BROWN SOILS.
SIEROZEMS AND DESERT SOILS.
SOILS OF THE MOUNTAINS AND MOUNTAIN VALLEYS (COMPLEX).
A – SOIL MATERIAL LARGELY OF ALLUVIAL ORIGIN.
AFTER GLINKA, MARBUT AND OTHERS
180
150
120
90
60
30
0
30
60
90
120
150
180
60
30
0
30
60

Fig. 1. Schematic map of important soil groups.

Prassolov (*Pedology*, 1946, No. 2) estimates the areas of the world in 10 broad classes of soils, as follows:

	Per cent
Chernozems	6
Chernozem soils of prairies	
Black soils of tropical regions	
Chestnut soils of dry steppes, (including Solonetz)	7
Gray forest	7
Brown forest	
Slightly leached soils of dry forests	
Alluvial soils, marshes, and swamps of tropical regions	4
Podzols (including bogs)	9
Red soils of subtropics	19
Reddish-brown soils of tropical savannas	
Red soils of tropical forests	
Lateritic soils	
Sierozems and other soils of desert steppes and oases (including Solonchaks)	17
Sands and stony soils of the deserts	
Mountain tundra	16
Mountain meadows	
Mountain-forest podzols	
Mountain-forest brown soils	
Mountain-forest red soils	
Soils of mountain steppes	
High mountain deserts	
Tundra	4
Everlasting snow and ice	11

The podzols of the North Temperate Zone and the red soils of the tropics and subtropics constitute the extensive soils onto which great expansion of food production might be possible. Although these occupy an estimated 28 per cent of the world land area, probably less than 1 per cent is now under cultivation. It is recognized, of course, that a large proportion of these soils are unsuitable for agriculture because of the unfavorable topography and stoniness.

The principal areas of red soils are in Africa, South America, southeastern Asia, including India, the Pacific Islands, and southeastern North America. Most areas of red soils are now in use in southeastern Asia and India, and large areas are in use in some of the Pacific Islands and in the United States; but their resources are almost untouched in Africa and South America. If we assume that only 20 per cent of the red soils of the tropics in South America and Africa alone were to be brought into production, about 900,000,000 acres would be added for food production. To these potential cultivated new areas of red soils may be added a large area of uncultivated tropical soils found on the great islands of Sumatra, Borneo, New Guinea, and Madagascar. Assuming, then, that at least another 100,000,000 acres of red tropical and alluvial soils are available in these and other warm parts of the world, the total of 1,000,000,000 acres of tropical and subtropical soils may be used in calculating world soil potentialities.

The podzols, located almost wholly in the northern part of the Northern Hemisphere, are found mostly in Soviet Russia, Canada, and the United States. If we were to assume that only 10 per cent of these soils were brought into cultivation, another 300,000,000 acres would be added to the world acreage for food production.

The world's uncultivated areas are, of course, generally less fertile than those already under cultivation. To maintain continued productivity, these would need fairly-heavy fertilization. The question of serious erosion, especially in the tropical areas, must be met if there is to be expansion in this direction. In the last two decades, however, a body of science dealing with erosion control has been developed, which gives us confidence that the problem can be met adequately. We can develop; we need not exploit.

If this huge body of 1,300,000,000 acres of new land were brought into production, what would be the world food picture? Here again, we must estimate by making comparisons with production figures from similar areas. For estimating the possible production of the 1,000,000,000 acres of tropical land, we have chosen the Philippines as a yardstick because it is one of the few tropical countries that can be considered fairly representative of the tropical soil region and that had even approximately complete food-production records. Finland was chosen similarly as representative of the 300,000,000 acres available in the podzol group. By applying the approximate production per acre of the principal classes of food obtained in the Philippines to the above acreage of tropical soils and that obtained in Finland to the acreage of podzol soils, we arrive at the data presented in Table 3.

World food needs in 1960 could thus be met for all classes of food except meat, milk, and pulses and nuts, by production increases on present cropland acreage plus the production of 1,000,000,000 acres of tropical soils, if these soils were used as intensively and for the same classes of food products as are the cultivated soils of the Philippines. We could have more than enough cereals, roots and tubers, sugar, fats and oils, and fruits and vegetables. In addition, the need for pulses and nuts could be easily met or exceeded by shifting some of the production of coconuts from oil to edible nuts.

If production of 300,000,000 acres of North Temperate Zone soils were added to the increase from the present cropland and used as intensively and for the same classes of food products as are the cultivated soils of Finland, the world food needs in 1960 would be met for cereals, roots and tubers, sugar, and milk, and, in addition, the need for fats and oils would be very nearly met.

World production from all our three sources combined —present world cropland, 1,000,000,000 acres of new tropical, and 300,000,000 acres of extratropical soils—would exceed world food needs for all classes of food except pulses and nuts, under the assumption used, and would exceed them for all classes if part of the production of coconuts were shifted from coconut oil to edible nuts. Production of cereals, roots and tubers, sugar, and fats and oils would be far in excess of what is needed.

TABLE 3

POTENTIAL FOOD PRODUCTION IN MILLIONS OF METRIC TONS FROM MORE INTENSIVE USE OF EXISTING CROPLAND PLUS DEVELOPMENT OF ADDITIONAL LAND NOT NOW CULTIVATED

	Cereals	Roots and tubers	Sugar	Fats and oils	Pulses and nuts	Fruits and vegetables	Meat	Milk
Attainable production from present cropland....	360.0	230.0	34.5	18.0	43.4	211.0	78.7	180.2
Attainable production from present cropland plus 1,000,000,000 new acres tropical soils*	717.5	469.5	177.5	69.5	55.4	470.0	89.4	188.8
Attainable production from present cropland plus 300,000,000 new acres land outside tropics†	395.5	296.0	35.1	19.4	44.2	211.0	86.1	314.6
Attainable production from all above sources....	753.0	535.5	178.1	70.9	56.2	470.0	96.8	323.2
World food needs in 1960....	363.5	194.5	33.6	20.4	65.2	411.0	95.8	300.0

* Obtained by applying approximate average production per crop acre in the Philippine Islands to 1,000,000,000 acres.

† Obtained by applying approximate average production per crop acre in Finland to 300,000,000 acres of Northern Hemisphere soils. Fats and oils and fruits and vegetables are *underestimated* because Finnish production figures on farm-made butter, meat, fruits, and vegetables were unavailable.

To meet world food needs, then, much less than all of these sources of production could be required if efforts were made to produce primarily those classes of foods in deficit.

In discussing potential world food production, either through intensified farming of old land or by developing new areas, there is one overlying factor affecting both. Greatly increased quantities of fertilizer will be required. How adequate are world supplies of fertilizers?

Since nitrogen fertilizer can be manufactured by fixation of nitrogen from the atmosphere, world supplies are limited only by the capacity of plants to produce. This plant capacity was expanded greatly in the last decade because nitrates are a necessity of war.

With phosphate and potash, on the other hand, we must depend on natural deposits to fill world needs. Table 4 compares probable phosphate and potash supplies with potential needs for meeting world food goals. Again it is necessary to make several assumptions. First, we assume that present world cropland would scarcely need a heavier rate of application than is now used in France. It will be noted that the rate of fertilization in France is several times the present world rate. Second, we assume that the additional 1,000,000,000 acres of tropical soils would scarcely need heavier applications than the rate in Hawaii, which is among the highest for all tropical areas. Third, we assume that the 300,000,000 acres of extratropical soils will again need no heavier rate of application than that of France. Thus, in all three areas for comparative purposes we have chosen countries that use fertilizer at a relatively high rate, so that the estimate on world reserves would be conservative.

TABLE 4

FERTILIZER IN RELATION TO EXPANDED FOOD PRODUCTION*

Rate of fertilizer use in kg./hectare of land used for crops:

	P_2O_5	K_2O
World...	5.0	3.2
United States....	4.9	2.6
France..	17.1	12.7
Hawaii..	41.0	80.0

World annual requirement of fertilizer under expanded food production:

	P_2O_5 (metric tons)	K_2O (metric tons)
On 1,940,000,000 acres existing cropland at rate of France....	13,425,000	9,970,000
On 1,000,000,000 acres (new) tropical soils at rate of Hawaii.....	16,400,000	32,000,000
On 300,000,000 new acres extratropical soils at rate of France....	2,000,000	1,500,000
Total....	31,825,000	43,470,000

	P_2O_5 (billion metric tons)	K_2O (billion metric tons)
Probable world reserves...	66	22.5
	(years)	(years)
Years supply will last under expanded food production....	2,000	500

* Data on fertilizer use from USDA Misc. Publ. 593.

The resulting quantities of fertilizer used under these conditions would be about 8 times the present consumption of phosphate and nearly 18 times the present consumption of potash. Even so, the known world reserves of phosphate would last more than 2,000 years and the known reserves of potash 500 years. The world has not been thoroughly explored for these minerals. Doubtless the actual reserves greatly exceed the known reserves.

There are also many sources of potash other than those included in the probable reserves that may be developed when economical methods of extraction are devised. This latter point again emphasizes how conservative these estimates are, for no allowance was made for technical improvements, which are sure to come in the fertilizer industry.

Here, then, is an affirmative answer to the question: Do we have the natural resources to meet world food goals by 1960? This answer is a challenge to all men, not to scientists only, for it raises immediately an even more critical question: Can we mobilize these resources to produce the needed food? This question begs many answers, because it involves the whole field of human relationships.

Science may discover and point the way, but it cannot dictate. The full measure of success in economic, social, and political action comes only with the will of the majority—not from the desires of one group.

If the people of the world really have the determination to give battle to the problem of hunger, if they are willing to extend a small part of the energy and capital poured into World War II, only then can we see hope of victory.

Modern Concepts of Inflammation

Valy Menkin

Department of Surgical Research and Agnes Barr Chase Foundation for Surgical Research, Temple University School of Medicine, Philadelphia

INFLAMMATION IS THE PHYSICAL BASIS OF infectious diseases, although inflammation and infection should not be considered as synonymous terms. Inflammation implies a more inclusive concept. It is a manifestation of severe cellular injury in higher forms. As such, the inflammatory reaction requires the presence of vascular and lymphatic structures as well as tissue cells. The reaction, which is initiated by a disturbance in fluid exchange, manifested primarily by an increase in capillary permeability, tends to be stereopatterned. It can be modified by the nature of the irritant, which, per se, has its specific chemical affinity with the tissues of the host. Furthermore, the topographical location of the injury doubtless alters the ultimate picture of the lesion. Nevertheless, close scrutiny reveals throughout a fundamental pattern which is largely referable to various basic common denominators or biochemical units liberated by injured cells, irrespective of the nature of the stimulating irritant. It therefore behooves us to concentrate on a study of the biochemistry of injured cells.

The initial increased capillary permeability and the early migration of polymorphonuclear cells is primarily caused by a polypeptide to which there may be attached a prosthetic group. This substance, called *leucotaxine*, was identified in exudative material some 10 years ago. It is not possible here to go into the details employed in its isolation and properties. Suffice it to say that leucotaxine has no similarity to histamine and, as such, has no relation to the so-called hypothetical H-substance of the late Sir Thomas Lewis. It evidently is wholly different from hyaluronidase, acetylcholine, or adenine compounds. Cullumbine and Rydon in Great Britain have recently confirmed by a somewhat different procedure of extraction its presence in exudates and also its properties (*Brit. J. exp. Path.*, 1946, **27**, 33).

Leucotaxine fails to alter the number of circulating leucocytes when administered intravenously. It appears as if the state of leucocytosis accompanying a number of inflammatory processes is caused by a wholly different basic factor or common denominator. When exudative material, particularly, though not always, at an alkaline pH, is injected into the blood stream of a normal dog, a rise in the number of circulating leucocytes occurs. This rise may take place in an hour in some animals, whereas in others it may be significant in only three to four hours. Thus, a leucocytosis-promoting factor is liberated by injured cells, which can in turn be recovered from exudates. Neither normal blood serum nor saline can produce any such prompt response as exudative material. The factor abbreviated as the LPF is thermolabile and nondiffusible. It can be extracted in the pseudoglobulin fraction of exudates by fractionation with $(NH_4)_2SO_4$. Recent cataphoretic studies in collaboration with Dr. Gerald Cooper and Mr. Dillon, of the Duke University School of Medicine, suggest its association with the α^1 and α^2 globulins of exudates. In as yet unpublished studies by the writer, it has been found that by aging the LPF the material seems to denaturate spontaneously, and then it becomes insoluble. The active principle, however, splits off from the original protein molecule as a soluble component, which in preliminary tests appears to be polypeptide in nature.

Alpha Omega Alpha Lecture delivered at the Woman's Medical College of Pennsylvania, Philadelphia, November 8, 1946. Presented also as a seminar before the Department of Biology, Bryn Mawr College, January 8, 1947.

The leucocytosis-promoting factor, or LPF, of exudates reasonably explains the mechanism of leucocytosis with inflammation. The LPF induces a discharge into the circulation of immature granulocytes. It is also present in human exudates, but, as already mentioned, it is absent from normal blood serum except when there is a concomitant acute inflammation.

The LPF has, likewise, a specific growth effect on some of the elements of the bone marrow. Its administration is rather quickly followed by a hyperplasia of granulocytes and of megakaryocytes. These various properties possibly imply some clinical application, for it is well known that the prognosis of infectious processes depends to a large extent on the number of circulating leucocytes.

Recent studies at Duke University indicate that the canine LPF is both innocuous and active on human beings (*Arch. Path.*, 1946, **41**, 376) when administered intravenously. New studies by the writer demonstrate that with an already-existing inflammation the superimposed intravascular introduction of a single injection of LPF induces a synergistic effect, so that the number of circulating leucocytes remains elevated for markedly longer periods (on the average, about 9 times longer) than in control animals with an inflammation alone or in animals which have received only a single injection of LPF. These studies definitely point toward clinical implications in an endeavor to reinforce the commonly used antibiotics. The LPF can be assayed conveniently on guinea pigs. The canine material is likewise promptly active on these animals, even when injected subcutaneously.

The reaction of injury with inflammation is basic and fairly stereotyped. It includes the four cardinal features of Celsus, the loss of function of John Hunter, and the chemical breakdown of proteins, namely, proteolysis. Although, as pointed out earlier, the irritant and the location of the lesion may alter its ultimate appearance, a basic similarity can, nevertheless, be roughly discerned. This injurious reaction by the tissues of the host has been found to be referable to the euglobulin fraction of the exudative material. There is thus liberated by injured cells a toxic substance which has been termed *necrosin*. Necrosin is either a euglobulin or is associated with this fraction of exudates. Its cutaneous injection is followed by swelling, redness, varying degree of central necrosis, lymphatic blockade, injury to the endothelial wall of blood vessels, and swelling of collagenous bundles. Necrosin is absent in normal blood serum, but it can be recovered frequently from the serum of an animal with a concomitant inflammation. This fact may be of significance in revising our views on so-called foci of infections, with their repercussions on organs at a distance. For this reason, observations were undertaken to determine the effect on various structures of intravascular injections of necrosin (*Arch. Path.*, 1943, **36**, 269). There is almost constant injury to the liver. This may be in the form of a curious stippling granulation in the hepatic cords, or the liver cells may display a prominent degree of vacuolation with scattered areas of leucocytic infiltrations. Dogs were also repeatedly injected intravascularly with this toxic material over a space of weeks. Large amounts of either glycogen or fat replaced a good deal of the normal hepatic tissue. These deposits of glycogen were found not to be referable to feeding. It has been found that injections into the circulating blood of exudative material or of necrosin induce a small rise in the blood sugar level. Whether this small but constant augmentation in sugar concentration is referable to the apparent specific effect of necrosin on the liver remains to be determined. Varying degrees of injury to the kidneys following necrosin injection may also occur.

The whole euglobulin fraction of exudates not only induces a conspicuous degree of cellular damage but also causes both a rise in temperature and a marked drop in the white cell count—a state of leucopenia.

By a method of differential solubility the fever-inducing factor has been dissociated from the true euglobulin fraction of usually acid exudate, which in turn is, or at least contains, necrosin (*Arch. Path.*, 1945, **39**, 28). This pyrogenic factor, which can reasonably explain the mechanism of fever with inflammation, has been termed *pyrexin*. It is capable of increasing the temperature of a rabbit or of a dog 2° or 3° F. It is a thermostable factor; boiling fails to inactivate it. It is conceivable that its action is central, for nembutal and antipyretics tend to reduce its action. Its frequent occurrence from non-pyrogenic necrosin by merely incubating the latter suggests that pyrexin may perhaps be the end-product of proteolytic degradation, especially since some protein enzymatic activity is found to be present in necrosin. It appears to be eliminated to some extent in the urine. Some studies in collaboration with Frederick Bernheim, of Duke University, indicate the possibility that pyrexin is a glycopeptide, but further studies are necessary before this view becomes a certainty.

The leucopenic factor of exudates seems to be closely associated with pyrexin. It can be dissociated from the latter by hydrolyzing it briefly with 0.1 N HCl and subsequently neutralizing it with N NaOH. The presence of such a factor in exudative material, particularly if the exudate is at an acid pH, may be of help in explaining the leucopenia attending numerous inflammatory processes, such as influenza and typhoid fever. The presence of this factor in exudates, probably liberated by injured cells, opposes the LPF in its mode of action. The actual level of white cells in the circulation may prove to be the resultant of these opposing tendencies on the part of the two different factors. The mode of action of the leucopenic factor, which appears to be a polypeptide, seems to be a trapping of leucocytes in various organs such as the alveolar walls of the lungs, the sinusoids of the liver, and the spleen. The trapping of leucocytes in the spleen may help in our understanding of the mechanism of the acute splenic tumor which is frequently seen with many inflammatory processes.

I believe that sufficient material has been presented to stress the necessity of studying thoroughly the biochemistry of cells injured previously by an irritant. The several common denominators already identified in exudative material are shown in Fig. 1. Doubtless, further studies will unfold other types of common denominators or biochemical units which, per se, help in explaining the stereotyped reaction with inflammation.

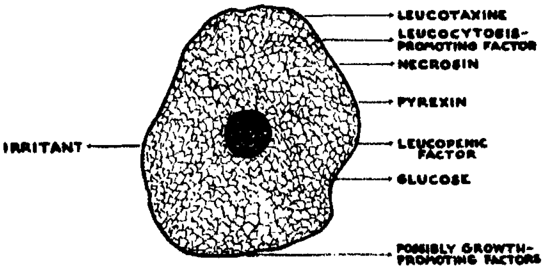
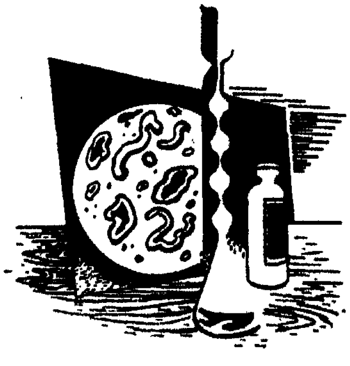

LEUCOTAXINE
LEUCOCYTOSIS-PROMOTING FACTOR
NECROSIN
PYREXIN
IRRITANT
LEUCOPENIC FACTOR
GLUCOSE
POSSIBLY GROWTH-PROMOTING FACTORS

FIG. 1

A recapitulation of the salient points in the development of the acute inflammatory reaction, which localizes an irritant and finally disposes of it, may be useful. Such an outline may be presented in brief as follows:

(1) *Disturbance in local fluid exchange:*
  (A) Increased capillary permeability, referable to liberation of leucotaxine, a crystalline nitrogenous substance.
  (B) Initial increase in lymph flow.
(2) *Localization of irritant (fixation)*, referable to lymphatic blockade by occluding thrombi and a fibrinous network at the site of severe inflammation:
  (A) **The inflammatory reaction may be considered as the regulator of bacterial invasiveness, *i.e.* $D = \frac{Kt}{I}$ where D refers to dissemination; I, to degree of local injury; t, to time; and K is a constant.**
(3) *Migration of leucocytes:*
  (A) Diapedesis of polymorphonuclear leucocytes, referable to liberation of leucotaxine. In this way phagocytosis, stressed by Metchnikoff, can operate readily. The mechanism whereby macrophages assemble at the site of injury is still not exactly known.
  (B) Cytological sequence at the site of inflammation conditioned by the local pH, in turn referable to a disturbance in carbohydrate metabolism; glucose formed by injured cells by deamination of proteins.
  (C) Leucocytosis in the circulation, referable to liberation of a leucocytosis-promoting factor demonstrable in association with the pseudoglobulin fraction of exudates. The LPF induces a concomitant growth of granulocytes and of megakaryocytes in the bone marrow.
(4) *The pattern of injury in inflammation*, referable to the liberation of a toxic substance in the euglobulin fraction of exudates, termed necrosin. This fraction contains proteolytic activity.
  (A) Fever with inflammation, referable to liberation of pyrexin in exudative material.
  (B) Leucopenia with inflammation, possibly associated with the liberation of a leucopenic factor in exudates.
  Both pyrexin and the leucopenic factor are, with necrosin components, recovered from the euglobulin fraction of exudates.
(5) *Repair*, possibly referable to the liberation of one or several growth-promoting factors in exudates.



Obituary

John Lewis Sheldon

1865–1947

John L. Sheldon, former professor of botany at West Virginia University, died at his home in Morgantown on January 15, 1947. He had passed his declining years in seclusion, but retained to the last an active interest in his chosen science.

He was born at Voluntown, Connecticut, on November 10, 1865. He was educated in the elementary schools of Connecticut and was a teacher in the school system of the state from 1885 to 1890. From 1892 to 1894 he was an instructor in the Mt. Hermon School. After receiving the B.S. and B.Pd. degrees from Ohio Northern University in 1895, he again became a teacher in the Connecticut public schools, continuing in this position until 1898, when he began teaching in the preparatory school of the University of Nebraska. Proceeding with graduate work, he received the B.S. degree from Nebraska in 1899 and the M.S. degree from Ohio Northern the same year. During 1899–1900 he was a teacher in the Nebraska State Normal School. From 1900 to 1903 he was an instructor of botany at Nebraska, where he continued his graduate work, receiving the A.M. and Ph.D. degrees in 1901 and 1903, respectively. He was appointed professor of bacteriology at West Virginia University in 1903 and professor of botany and bacteriology in 1907. In 1913 he was designated as professor of botany, which position he retained until his retirement in 1919.

While at West Virginia University, Dr. Sheldon made many trips over the state, carefully studying the plant life and making extensive collections. His field work added a large number of species to the previously known flora of the state, many of which were published in Millspaugh's *Living flora of West Virginia* (1913). Although he was especially interested in cryptogams, he found time also to collect thousands of specimens of phanerogams. He was a collaborator of the Bureau of Plant Industry, U. S. Department of Agriculture, from 1902 to 1903 and from 1905 to 1922. A long bibliography of his botanical writings was published recently in *Castanea* (1939, **4**, 72–74). At the age of 74 he completed an exhaustive study of the lichens of West Virginia (see *Castanea*, 1939, **4**, 75–126).

He was a member of the American Association for the Advancement of Science, the Phytopathological Society, the Genetic Association, the Sullivant Moss Society, the Southern Appalachian Botanical Club, Sigma Xi, Phi Beta Kappa, and Phi Epsilon Phi.

He was a teacher of the classical school, and his enthusiasm was an inspiration alike to his students and associates. Throughout the long years of his retirement when failing health interfered with his normal pursuits, he retained his interest in his former students, and his friends were always heartily welcomed at his home.

EARL L. CORE

West Virginia University, Morgantown

Philip W. Schutz

1908–1947

Philip W. Schutz, professor of chemical engineering at the University of California, died at Permanente Hospital, Oakland, on March 7, 1947.

Dr. Schutz was born in St. Louis and received his education there through B.S. and M.S. degrees in chemical engineering at Washington University. He received the Ph.D. degree from the University of California in December 1933 and served as instructor at that institution until June 1934. After a year with the Shell Oil Company at Martinez, California, he returned to the University to serve as research associate to the late Gilbert N. Lewis for the period 1935–37. Then for three years he was instructor of chemical engineering at Washington State College, Pullman.

In 1940 Dr. Schutz went to Columbia University as assistant and later associate professor of chemical engineering. During the war years he served as consultant to the National Defense Research Committee and to the Manhattan Engineering District on several important projects. In 1946 he returned to the University of California as professor of chemical engineering.

The fields in which Dr. Schutz made his major scientific contributions and in which he was regarded as a leader were chemical and chemical engineering thermodynamics and dielectric heating. In the former field he published several papers with Wendell M. Latimer on the entropies of aqueous ions and with Gilbert N. Lewis on heavy water and deuterium compounds. Later he contributed to the general theory of azeotropic solutions and detailed data for several systems. Most recently he undertook a fundamental study of dielectric heating.

KENNETH S. PITZER

Department of Chemistry,
University of California, Berkeley

NEWS *and Notes*

Paul A. Jenkins has been elected general chairman of the local committees directing preparations for the 114th meeting of the AAAS, to be held in Chicago December 26–31, 1947 (*Science*, April 18). As executive secretary of the Chicago Technical Societies Council, a federation of 50 local sections of scientific, engineering, and technological societies, he is eminently qualified to supervise convention arrangements. During World War II he was in charge of operations of the War Production Board in Northern Illinois, including Chicago. Prior to the war he was active in advertising and sales management.

On May 12 the chairmen of the subcommittees in Chicago met for the first time to report to the general chairman. The Equipment Committee had undertaken to survey the availability of meeting rooms in educational institutions near the headquarters hotels as the result of prospective charges of $6,000–$8,000 for the use of hotel session rooms. It was reported that all sessions of the convention may be accommodated in rooms made available at no charge either within the Loop or just a few moments distant by bus or streetcar, if the hotels cannot be dissuaded from charging for the use of their session rooms.

At this meeting George M. Schmeing, chairman of the Chemistry Department, Loyola University, assumed the chairmanship of the Reception and Entertainment Committee.

About People

J. Robert Oppenheimer, wartime director of the atomic bomb project at Los Alamos, New Mexico, and professor of physics, University of California and California Institute of Technology, has been appointed director of the Institute for Advanced Study, Princeton, New Jersey. He will succeed Frank Aydelotte, who will retire in September. Dr. Oppenheimer will continue as a member of the Joint Army-Navy Research and Development Board and as chairman of the general advisory committee appointed by President Truman to assist the Atomic Energy Commission.

Herman F. Mark, director of the Institute of Polymer Research and professor of organic chemistry, Polytechnic Institute of Brooklyn, has been invited to accept the Chair Franccki at the University of Liège, Belgium, for the academic year 1947–48. The guest professorship, which involves a six-month lecture tour of several Belgian universities, has previously been held by P. Debye, H. S. Taylor, A. Szent-Györgyi, and Victor Henry.

William C. Steere, professor of botany, University of Michigan, and editor of *The Bryologist*, has been appointed chairman of the Department to succeed H. H. Bartlett, who leaves this month to aid in rehabilitation work at the University of the Philippines. Dr. Bartlett will resume his position as professor of botany and director of the Botanical Garden upon his return to the University.

Edwin Y. Webb, Jr., Office of Technical Services, U. S. Department of Commerce, left for Germany April 10 to obtain detailed information on German technological developments in which American electronics and communications industries have expressed particular interest. Mr. Webb will investigate microdot photography; variable-speed facsimile monitoring equipment; automatic telegraph systems; gold-plated surfaces in glass-to-metal seals in electron tubes; velocity-modulated and cold cathode electron tubes; selenium photocells; Telefunken ceramic tubes; and powdered iron cores for high-frequency applications. The results of the investigations will be released to the public through the Office of Technical Services.

J. H. Van Vleck, chairman of the Department of Physics, Harvard University, was the principal speaker at the annual Sigma Xi public lecture at the University of Oklahoma on April 24. His subject was "Microwave Spectroscopy."

Donald B. McMullen, associate professor of preventive medicine and public health, University of Oklahoma School of Medicine, has been granted a two-year leave of absence to accept appointment as senior parasitologist with the Armed Services in Japan, where he will be attached to the 406th Medical General Laboratory, Tokyo.

Alfred W. Gauger, professor of fuel technology and director of the Mineral Industries Experiment Station, Pennsylvania State College, delivered the 21st annual Priestley Lecture Series April 21–25 at the College. The Priestley Lectures were established in 1926 as a memorial to Joseph Priestley and, since 1931, have been sponsored jointly by the local chapter of Phi Lambda Upsilon, honorary chemical society, and the Department of Chemistry. Dr. Gauger's subject was "Physical Chemistry and the Technology of Fuels."

Raimon L. Beard, entomologist, has returned to the Connecticut Agricultural Experiment Station after a year's leave of absence, during which he was with the Chemical-Biological Coordination Center, National Research Council.

Wendell M. Stanley, of the Rockefeller Institute, Princeton, New Jersey, winner of the 1946 Nobel Prize in chemistry (*Science*, November 22, 1946), will deliver the 1947 Edgar Fahs Smith Memorial Lecture in the auditorium of the University of Pennsylvania, Philadelphia, on June 5. Dr. Stanley will discuss "Recent Studies on Viruses."

Inaugurated in 1929, the lecture series was sponsored by the chemistry faculty of the University until World War II. With resumation of the series last year, the Philadelphia section of the American Chemical Society became co-sponsor with the University.

P. F. Scholander, research biologist Swarthmore College, is attending conferences on zoophysiology at the University of Oslo.

S. R. Detwiler, professor of anatomy, College of Physicians and Surgeons, Columbia University, delivered the 16th annual James Arthur Lecture on the Evolution of the Human Brain at the American Museum of Natural History, New York City, on May 8. He spoke on: "Structure-Function Correlations in Developing Nervous System as Studied by Experimental Methods."

Willy Baensch, from 1929 to 1945 professor of radiology and cancer research and director of the cancer hospital, University of Leipzig, has been appointed professor of roentgenology at the Georgetown University School of Medicine, Washington, D. C. Dr. Baensch, who was elected secretary-general of the International Congress of Radiology at the last meeting in Chicago in 1937, is co-author with Drs. Schinz and Friedl of the *Manual of roentgen diagnosis*.

Grants and Awards

The John Wesley Hyatt Award for the Advancement of Plastics, consisting of a gold medal and $1,000, was presented to John J. Grebe, director of the Physical Research Laboratory, Dow Chemical Company, Midland, Michigan, on April 23 for his work in the production of pure styrene and its polymerization. Robert R. Dreisbach, staff member of the same laboratory, received a silver medal from the Award Committee for his contribution to the development of styrene.

Gladys S. King, at the 94th annual meeting of the New Orleans Academy of Sciences, was awarded the 1947 Research Grant, contributed equally by the New Orleans Academy of Sciences and the AAAS, for a study of the effects of 2,4-D on plant growth substances in water hyacinth and alligator weed.

Albert F. Blakeslee, director, Genetics Experiment Station, Smith College, Northhampton, Massachusetts, was awarded the Gold Medal of the Massachusetts Horticulture Society at a meeting of the Board of Trustees on January 7 for his contributions in the field of genetics and his contribution as an author along botanical and horticultural lines. Recognition was also made of Dr. Blakeslee's initiation of the use of colchicine in plant breeding.

Sharp & Dohme, Inc., has announced the award of three new research grants and the renewal of a fourth. The new grants have been made to: O. P. J. Falk, consultant at the St. Louis City Hospital, St. Louis, Missouri, in support of a clinical study to evaluate caronamide as an adjunct of penicillin in the treatment of infectious diseases; C. M. Hendricks, El Paso Medical and Surgical Clinic, in support of an extensive clinical study on the use of tyrothricin and other preparations as an aerosol; and Marshall C. Cheney, physician in charge of student health, University of California, Berkeley, in support of research on the prevention of the common cold by means of respiratory vaccines. A grant to Tulane University was renewed to allow C. Gordon Johnson to continue research on clinical problems that involve sulfathalidine phthalylsulfathiazole and sulfamerazine in pre- and postoperative urinary tract infections.

Joseph M. Hill, director of the William Buchanan Blood Center, Baylor University, Dallas, Texas, and professor of clinical pathology at Southwestern Medical College, received the first Marchman Award for notable research in medicine at the annual dinner of the Dallas Southern Clinical Society, January 21. Dr. Hill won the award for his recent investigations of the Rh factor. Named for the first president of the Clinical Society, Oscard M. Marchman, the award will be made annually except in years when there are no outstanding candidates.

Norman Arnold Nielsen, metallurgical engineer in the Engineering Research Laboratory of the Du Pont Company's Experimental Station, Wilmington, received the 1946 Young Authors Prize at the spring meeting of the Electrochemical Society. The award is given annually to authors under 27 years of age for the best technical paper in the year's publications of the Society. Dr. Nielsen's winning paper, "Passivation of Stainless Steel," written with E. M. Mahla, also of the Du Pont Experimental Station, included an evaluation of the various treatments for increasing the resistance of stainless steel to corrosion.

W. W. Norton & Company is again offering the Norton Medical Award for book manuscripts written for the lay public by professional workers in the field of medicine. The Award, which offers $5,000 as a guaranteed advance against royalties, is not being limited to any one year, and there is no final date for submissions. Either complete manuscripts or detailed table of contents, together with 100 pages of manuscript, may be submitted. A descriptive folder giving full details of the terms of the Award may be secured on request from the Company at 101 Fifth Avenue, New York 3, New York.

The Washington Academy of Sciences, at a meeting March 20, presented certificates of award for outstanding achievement in the biological, engineering, and physical sciences to: Waldo R. Wedel, U. S. National Museum, for his contribution to knowledge of the prehistory of human ecology in the central great plains; Martin A. Mason, Beach Erosion Board, War Department, for erosion studies leading to successful Allied beach invasions during the war; and George W. Irving, Jr., U. S. Bureau of Agricultural and Engineering Chemistry, for service in biochemistry, especially antibiotics in tomato plants.

Colleges and Universities

An Electric Analog Computer will be part of the new Analysis Laboratory now being established at the California Institute of Technology, according to announcement by Gilbert D. McCann, associate professor of electrical engineering at the Institute, who is setting up the laboratory.

The new calculator, which will be made available to all interested industrial and engineering organizations as well as being used for research at the Institute, will be in partial operation by June 1 and is expected to be completed by August. Weighing approximately 33,000 pounds, the machine, including its control desk, will occupy some 1,000 square feet of floor space. The device was designed for the solution of complex mathematical problems in the field of algebra and calculus requiring an accuracy of the order of 1 per cent. It is particularly suited to solving engineering problems, including those of electrical circuits; applied mechanics; self-induced mechanical oscillations, such as airplane structure flutter, car shimmy, rail car stability; problems in thermodynamics, such as a general analysis of heat flow problems; speed controllers, voltage regulators; and angle position controllers, such as airplane stabilizers, guided missiles, gyro pilots, etc.

According to Dr. McCann, a similar computer is being built by Westinghouse.

Northwestern University has received a gift of $190,172, the first of several to total more than $500,000, from the Public Health Institute of Chicago for use in the projected $100,000,000 medical center on the University's Chicago campus. The fund will be used for expanded research in the field of venereal diseases, other public health problems, and medical education and for treatment and examination of patients in the medical school clinic. All equipment and other physical property of the Institute, which ceases operation this year after 26 years of operation as a nonprofit center for the treatment of venereal diseases, will be given to the University for use in connection with the fund.

The center will also have a neuropsychiatric hospital, provided by a bequest of $1,500,000 from the late Mrs. Joy Morton; a 600-bed cancer hospital, which will be built by the Veterans Administration; and new structures to house several of the established Chicago hospitals.

Industrial Laboratories

William C. Ellenbogen, formerly with the York Corporation, York, Pennsylvania, has joined the research staff of the Smith, Kline & French Laboratories, Philadelphia.

Edgar A. Thronson, of the Du Pont Company, has been appointed assistant director of the Technical Division, Electrochemicals Department.

Robert W. Elkas, formerly a Fellow of the Purdue Research Foundation, Purdue University, has been appointed assistant director of Pharmaceutical Control, Sharp & Dohme, Inc., Philadelphia.

M. F. Gribbins, a member of the Chemical Division of the Ammonia Department staff at the Du Pont Experimental Station since 1942, has been appointed to the Technical Service Section of the Ammonia Department. He will be concerned principally with development work relating to fertilizers and dairy and cattle feeds.

A new all-weather approach light system, developed by the Westinghouse Electric Corporation, permits visibility through 1,000 feet of the thickest weather, when objects 50 feet away cannot be seen in daytime. The system is a supplement to radar and radio aids, and not a replacement, since its usefulness begins when a plane reaches the approach portal, 3,500 feet from the end of the runway. Up to this point, a pilot is guided by instruments.

The system includes flash units, giving up to 3,300,000,000 beam candlepower, for use in zero-zero daytime; controllable blaze units that can be set to emit a soft red glow of about 100 candlepower for use on clear, moonless nights; and stages of candlepower suitable for any intermediate weather conditions.

A partial installation of this system has been tested at the Cleveland Municipal Airport. Tests have shown that the transition from instrument approach to visual landing can be accomplished under any condition of fog. The first full system will be installed at New York City's Idlewild Airport within eight months.

Vladimir Kosma Zworykin has been elected vice-president and technical consultant of the RCA Laboratories Division, Radio Corporation of America. Formerly director of the Electronic Research Laboratory, Princeton, New Jersey, Dr. Zworykin joined RCA in 1930.

During the war he directed television and radar research. In radio and electronic research for RCA he invented the iconoscope, television's electronic "eye," and developed the kinescope, electronic picture tube of the television receiver. He directed research on the first commercially practical electron microscope, for which he received the Rumford Award of the American Academy of Arts and Sciences in 1941. For work on television Dr. Zworykin received the Howard N. Potts medal of the Franklin Institute, announced in March 1947.

Meetings

The Laurentian Hormone Conference of the AAAS will meet September 8–13, at the Ste. Adele Lodge, Ste. Adele Quebec.

During the meeting the following papers will be presented: "The Mechanism of Action of the Plant Growth Hormones," Kenneth V. Thimann, Harvard University; "The Biochemistry of Pituitary Growth Hormone," Choh Hao Li, University of California; "The Effects of Hormones, Vitamins and Other Substances on Adrenal Function and Lipid Metabolism," Robert H. Williams, Thorndike Memorial Laboratory, Boston City Hospital; "New Syntheses in the Field of Estrogens," K. Miescher, Ciba Limited, Basle, Switzerland; "Steroid Excretion in Health and Disease," Seymour Lieberman, Memorial Hospital, New York City (chemistry), and Konrad Dobriner, Memorial Hospital, New York City (clinical aspects); "Urinary Steroids in Adrenal Disease," H. L. Maxon, Mayo Clinic; "The Chemical Histology of Endocrine Glands," Edward W. Dempsey, Harvard University; "Localization of Radioactive Compounds in Tissues," C. P. LeBlond, McGill University; "The Biology of the Interstitial Cells of the Testis," Charles W. Hooker, Yale University; "The Testis in Human Hypogonadism," Warren O. Nelson, University of Iowa; "Some Observations as to the Role of Testicular Secretions," James B. Hamilton, Long Island College of Medicine; "Regarding the Gonadotrophic Gonad Axis in Men," Carl G. Heller, University of Oregon; "The Renal Pressor System and Hypertensive Disease," A. C. Corcoran, Cleveland Clinic Foundation; and "Hypertension as a Disease of Adaption," Hans Selye, University of Montreal.

Since facilities of the Lodge are limited, membership in the Conference is established by invitation. Applications for membership by active investigators in the hormone field will be received by the Committee on Arrangements and its advisory committee. The members of the advisory committee are: B. J. Brent, H. M. Evans, H. B. Friedgood, R. G. Hoskins, H. Jensen, F. Koch, I. T. Nathanson, L. T. Samuels, E. Schwenk, M. L. Tainter, and A. White. Applications for membership may be made up to June 30, 1947, and should state if reservations for family members are desired.

The American Society of Mechanical Engineers, meeting in Chicago June 15–19, has planned its program about the 1947 theme, "The Engineer's Responsibility in Increasing National Productivity." In addition to the presidential address on "Broader Vistas," by Eugene W. O'Brien, addresses will be given by C. E. Wilson, General Motors Corporation, Robert R. Wason, National Association of Manufacturers, and others. One feature of the Wednesday evening banquet will be the presentation of the 1946 Alfred Noble Prize (administered by the American Society of Civil Engineers) to Martin Goland, Midwest Research Institute, Kansas City, for his paper, "The Flutter of a Uniform Cantilever Wing," which also won the Association's Junior Award. The technical sessions, to number about 40, will include: a meeting sponsored by the power division and the nuclear energy application committee, June 17; a meeting co-sponsored by the American Rocket Society, June 18; and a session on industrial instruments and regulators, with the Engineering Institute of Canada participating. Additional subjects to be considered in technical sessions are: machine design, fuels, materials handling, metals engineering, process industries, rubber and plastics, aviation, power, production engineering, heat transfer, railroads, oil and gas power, management, citizenship, and education.

The Committee on Medical Research of OSRD has announced the final disposition of the accumulated records of research carried on under CMR sponsorship during the years 1941–46.

Weekly Bulletin: Complete sets of the 78 issues of the CMR Weekly Bulletin, containing abstracts of the "open" and "restricted" reports received from CMR investigators and a subject index, entitled "Summary of Reports Received by the Committee on Medical Research," are being deposited in the following libraries: Beloit College Libraries; Boulder City Public Library; Brown University Library; California Institute of Technology Library; Carnegie Institute of Technology Library; Carnegie Library of Pittsburgh; Case School of Applied Science Library; Clarkson College of Technology Library; Clemson College Library; Cleveland Public Library; Colgate University Library; Colorado A. and M. College Library; Colorado School of Mines Library; Columbia University Libraries; Cornell University Library; Crerar Library, Chicago; Detroit Public Library; Duke University Library; Engineering Societies Library; Enoch Pratt Free Library; Georgia School of Technology Library; Government Printing Office, Washington, D. C.; Harvard College Library; Illinois Institute of Technology Library; Iowa State College of Agriculture Library; Johns Hopkins University Library; Joint University Libraries; Library of Congress; Library of the Franklin Institute of the State of Pennsylvania; Louisiana State University Library; Massachusetts Institute of Technology Library; Montana State College Library; New Mexico School of Mines Library; New York Public Library; North Carolina State College Library; Northwestern University Library; Norwich University Library; Ohio State University Library; Oregon State College Library; Pennsylvania State College Library; Polytechnic Institute of Brooklyn Library; Princeton University Library; Purdue University Library; Rensselaer Polytechnic Institute Library; Stanford University Libraries; State College of Washington Library; State University of Iowa Libraries; Texas Engineers Library; Texas Technological College Library; Libraries of the Universities of California, California (Los Angeles), Chicago, Cincinnati, Delaware, Denver, Florida, Idaho, Illinois, Kansas, Maryland, Michigan, Minnesota, Missouri, Nebraska, New Mexico, North Carolina, Notre Dame, Oklahoma, Oregon, Pennsylvania, Rochester, South Carolina, Tennessee, Texas, Utah, Virginia, Washington, and Wisconsin; Utah State Agriculture College Library; Virginia Polytechnic Institute Library; Washington University Library, St. Louis; West Virginia University Library; Western Reserve University Library; Woods Hole Oceanographic Institute Library; and Yale University Library.

Reprints: Bound and indexed sets of more than 1,000 reprints of published work done under OSRD-CMR contracts are being deposited with the following: Army Medical Library, Washington, D. C.; Boston Medical Library; Crerar Library, Chicago; Lane Medical Library, San Francisco; Library of the National Academy of Sciences, Washington, D. C.; Library of the New York Academy of Medicine; Library of the Philadelphia College of Physicians; and Tulane University Medical Library, New Orleans.

Malaria Reports: Indexed sets of the 734 numbered reports issued by the Board for the Coordination of Malarial Studies, as well as Army, Navy, British, and Australian malaria reports, have been deposited with the Library of Congress, the National Archives Library, and the Office of Technical Services, Department of Commerce. Photostatic copies of the reports can be purchased from the latter office.

Aviation Medicine Reports: A complete set of the 505 numbered reports issued by the National Research Council Committee on Aviation Medicine, including Army, Navy, and CMR reports, has been deposited with the Army Medical Library, Washington, D. C. Microfilm or photostatic copies of the reports that have been declassified may be purchased from the Library.

Final and Interim Reports of CMR Investigators: Copies of almost all of these reports are on file in the Office of Medical Records, National Research Council, 2101 . Constitution Avenue, Washington, D. C. Although these reports will not be sent out on loan, they may be consulted in that office.

Fresh eggs of wild American birds, however common, are desired by Hugh B. Cott, Cambridge University Museum of Zoology, Cambridge, England, for use in connection with a detailed investigation of the palatable and biochemical properties of birds' eggs. Dr. Cott would like to receive a complete clutch in the case of smaller birds; in the case of larger birds, one egg per species would be sufficient. The eggs should be collected fresh (before incubation) and sent air mail. Dr. Cott will pay the cost of freightage.

Former Sanitary Corps officers, including those still on active duty, are urged to communicate with Col. M. J. Blew to provide information for completion of an accurate postwar roster and for preparation of an analysis and evaluation of the activities of the Corps during the war. The following information is desired: rank; date called to active duty; present rank or rank on separation; specialty (engineering, entomology, parasitology, bacteriology, chemistry, nutrition, etc.); a résumé of pertinent facts regarding active-duty assignments; academic and professional degrees; professional and honorary society affiliations; whether registered or certified, etc.; and any comments or suggestions desired.

Communications should be addressed to: Col. M. J. Blew, ℅ National Society of Professional Engineers, 1359 Connecticut Avenue, N. W., Washington 6, D. C.

Make Plans for—

American Society of Heating and Ventilating Engineers, June 1–4, Coronado, California.

Institute of Food Technologists, June 1–4, Hotel Statler, Boston, Massachusetts.

American Society for the Study of Blood, organizational meeting, June 8, Hotel Claridge, Atlantic City, New Jersey.

American Institute of Electrical Engineers, summer general meeting, June 9–13, Montreal.

American Medical Association, centennial session, June 9–13, Atlantic City, New Jersey.

Meteoritical Society, 10th meeting, June 18–19, San Diego, California.

COMMENTS *by Readers*

In reply to Dr. Wright's criticism (*Science*, 1946, **104**, 190) of our note on the cause of nonresolvability of compounds of the type CabcCabc when the two asymmetric carbon atoms have opposite configurations (*Science*, 1945, **102**, 508), we are of the opinion that the concept of nonsuperimposability of mirror images is not a "trick" or a mere analogy, but is the necessary and sufficient condition for the existence of optical activity. The type of asymmetry necessary for mirror images of a molecule or crystal to be nonsuperimposable also is necessary for the retardation of one form of circularly polarized light with respect to the other and the production of a rotation of the plane of polarization of the resultant plane polarized light.

The assumption that the theory of Boys or of Kuhn can be applied to each half of the molecule CabcCabc separately, and added together algebraically when restricted rotation exists, assumes that the extent of rotation of the plane of polarization is independent of the path through the molecule. The theoretical treatments of Boys and of Kuhn deal only with models containing a single asymmetric carbon atom. Boys (*Proc. roy. Soc. Lond.*, 1934, **A144**, 655) postulates that the tetrahedral sets are distributed entirely at random in order to deal with an isotropic medium, thereby implying that the rotations of the individual molecules depend on their orientation. Kuhn (*Trans. Faraday Soc.*, 1930, **26**, 297, 302) states specifically that the rotation produced by the asymmetric molecule is dependent on the orientation of the molecule with respect to the light ray falling on it. In the discussion of Wolf's paper on restricted rotation (*ibid.*, p. 352) Kuhn points out that the rotation of one group with respect to the other will change the rotatory power of the molecule.

Our whole argument in the case of the compounds of the type CabcCabc is based on the fact that rotation is restricted and that the two halves of the molecule have a definite orientation with respect to each other. When this orientation is such that the mirror image is superimposable, the rotation produced by the molecule will be zero, regardless of the angle of incidence of the ray; but if the orientation of the two halves of the molecule is such that its mirror image is not superimposable, the rotation will be dependent on the angle of incidence. In the latter case the average rotation of randomly distributed molecules will be finite, because turning the molecule 180° through any axis does not influence the sign or extent of rotation of the individual molecules. If one wishes to consider the effects of the two halves of the molecule, the orientation of the two halves in the first case is such that the extent of rotation of the incident ray by one half is equal and opposite to that by the second half regardless of the angle of incidence; but in the second case the orientation of the two halves is such that the rotatory contributions of the two halves are equal in only two directions. Accordingly, if rotation is sufficiently restricted, we should expect one inactive, one *d*, and one *l* form when the configurations of the two asymmetric carbon atoms are enantiomorphic. Furthermore, the active forms resulting from restricted rotation when the two asymmetric carbon atoms have like configurations would have different rotations.

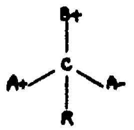


FIG. 1

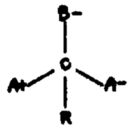


FIG. 2

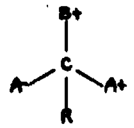


FIG. 3

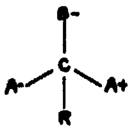


FIG. 4

While there seems to be little hope of preparing α,β-dibromo-α,β-diiodosuccinic acid, which we suggested might be separable into active isomers, we believe that a somewhat similar case is subject to experimental treatment. Figs. 1, 2, 3, and 4 represent 4 of the 8 forms possible for compounds of the type CAABR, where A and B are asymmetric groups, and R is a nonasymmetric atom or group. The molecules represented by Figs. 1 and 2 are enantiomorphic, as are those represented by Figs. 3 and 4. Shriner and Adams (Gilman's *Organic Chemistry.* (2nd ed.), p. 239) suggest that molecules represented by Figs. 1 and 3 should differ in physical properties but have identical rotations. It is our opinion that the rotations will not necessarily be identical, and we have been working intermittently over several years on the preparation of diastereoisomers of this type. The same considerations apply to Figs. 2 and 4.

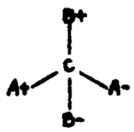


FIG. 5

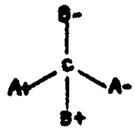


FIG. 6

An even closer analogy of the compounds of the type CabcCabc exists in the case of the forms of the compound CAABB, represented by Figs. 5 and 6. If the view of Shriner and Adams is correct with regard to the compound CAABR, then molecules corresponding to Figs. 5 and 6, which are enantiomorphs, should have zero rotation. It should be possible to synthesize compounds of this type also and decide the question by experimental results. (C. R. NOLLER, *Department of Chemistry, Stanford University.*)

* * *

Due to an oversight, in my article on "Origin and Evolution of Meiosis" (*Science*, March 14, 1947) the words meiosis and fertilization in diagram 5 were transposed. The reading should have been "*gametogenesis, fertilization, meiosis.*" (L. R. CLEVELAND, *Harvard University, Cambridge, Massachusetts.*)

TECHNICAL PAPERS

Inability of Thymine to Substitute for Folic Acid in the Rat

H. G. Petering and R. A. Delor[1]

Research Laboratories, The Upjohn Company,
Kalamazoo, Michigan

Pteroyl glutamic acid or vitamin B_c (folic acid or liver *L. casei* factor) has been shown to be a growth factor for microorganisms and an essential nutritional factor in preventing and curing "folic acid" deficiency in the rat, chick, guinea pig, and monkey. This compound has also been shown to have therapeutic value in correcting the blood dyscrasias of Addisonian pernicious anemia and other macrocytic anemias.

Thymine (5-methyluracil) has also been shown by Stokes (*6*) to be a substitute for pteroyl glutamic acid in the nutrition of certain lactic acid bacteria when used in an amount 3,300 times the folic acid requirement. This microbiological work has been confirmed and extended to include other pyrimidines by Hitchings, Falco, and Sherwood (*1*) and by Krueger and Peterson (*2*). Even though the mechanism of this action of thymine was obscure and probably not identical with that of folic acid, its action in human anemias was tried on the basis of these microbiological data. Spies and his associates (*5*) have shown that large doses of thymine (4.5 grams or more daily) will cause remission from Addisonian pernicious anemia or other macrocytic anemias, thus indicating that in humans as well as in microorganisms thymine may be involved in folic acid nutrition in some obscure way.

The lack of any reports on the action of thymine in alleviating folic acid deficiency in experimental animals prompts us to report our inability to find it a useful substitute for folic acid in the prevention or cure of folic acid deficiency in the rat.

METHOD

The experimental procedures were essentially those used by Mallory, *et al.* (*3*) and Spicer, *et al.* (*4*). Twenty-eight-day-old rats of random sex having an average weight of 45–50 grams were fed ad libitum a purified diet containing 2 per cent succinyl sulfathiazole (sulfasuxidine). The basal diet consisted of 71 per cent sucrose, 18 per cent casein (Labco vitamin free), 3 per cent cottonseed oil, 2 per cent cod-liver oil, 4 per cent salts (Sure, *7*), 2 per cent sulfasuxidine, 0.1 per cent choline chloride, 0.1 per cent inositol, and 200 γ per cent vitamin K (dissolved in the cod-liver oil). Daily supplements were made in a cup as follows: thiamine hydrochloride, 200 γ; riboflavin, 100 γ; pyridoxine hydrochloride, 100 γ; calcium d-pantothenate, 200 γ; nicotinamide, 500 γ; and biotin, 1 γ.

The data of our experiments are summarized in Table 1. In Experiment 1, the supplements were given between the 28th and 42nd days, the first four weeks being the depletion period marked by definite growth plateau. In Experiments 2 and 3 the supplements were given from the first day. The indicated supplements were fed along with the crystalline B vitamins. Conventional hematological techniques were used in all blood analyses.

Only in Experiment 2 was a positive control employed, namely, 3 γ of crystalline folic acid[2] supplied daily to each rat in the group. The response in growth and in white blood cell and granulocyte counts in this experiment is typical of our experience with folic acid, supplied either as crystalline product or as yeast or liver concentrates. In curative experi-

TABLE 1

EFFECT OF THYMINE SUPPLEMENTATION ON "FOLIC ACID" DEFICIENCY IN RATS FED PURIFIED DIET PLUS SUCCINYL SULFATHIAZOLE

Supplement	Thymine daily (mg.)	Folic acid equivalent (γ)	Experimental day	Gain in weight (grams)	R. B. C. (cells/mm.^{3} $\times 10^{-6}$)	Hb (grams/100 ml. blood)	HMCT volume (%)	W. B. C. (cells/mm.^{3} $\times 10^{-3}$)	Granulocytes (cells/mm.^{3} $\times 10^{-3}$)	Survival
Exp. 1										
Negative..........	—	—	28	46.3	—	—	—	—	—	—
			42	40.7	—	—	—	4.9	0.074	8/9
Thymine	15	4.2	28	34.0	—	—	—	—	—	—
			42	35.5	—	—	—	6.52	0.163	2/5
Thymine	7.5	2.1	28	35.8	—	—	—	—	—	—
			42	22.4	—	—	—	3.80	0.037	4/5
Exp. 2										
Negative	—	—	36	46	6.42	12.3	36.8	5.63	0.113	10/10
Thymine	15	4.2	36	43	7.19	11.5	36.2	6.57	0.131	9/10
Thymine	25	7.0	36	45	6.22	11.4	35.3	7.71	0.231	9/10
Pteroyl glutamic acid	—	3.0	36	92	7.97	13.9	42.1	13.75	1.650	10/10
Exp. 3										
Negative	—	—	35	40.7	7.40	14.1	40.4	5.50	0.055	10/10
Thymine	12	3.5	35	34.6	7.59	14.8	43.8	4.51	0.018	10/10
Thymine + PABA (2 mg.)	12	3.5	35	33.5	7.65	13.9	40.7	5.80	0.087	10/10
PABA (2 mg.)	—	—	35	47.0	7.40	13.5	41.8	4.26	0.043	7/10

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[1] The authors are pleased to acknowledge the assistance of H. B. Buskirk, Alice Bergdahl, Hallie Ferguson, and E. M. Stapert in carrying out the microbiological and hematological studies reported here.

[2] Supplied by E. L. R. Stokstad, of Lederle Laboratories, Inc.

ments similar to Experiment 1, we have found that 3 γ of folic acid given daily between the 35th and 49th days will allow a change in growth from about 93 grams to 140 grams, an increase in white cell count from about 4,000 to 10,000, and a change in the granulocyte count from about 300 to 1,000.

P-aminobenzoic acid has been previously tried for its effect on the syndrome produced with sulfasuxidine in rats fed a purified diet, but with little success. However, it was included in Experiment 3 to determine whether it might allow some subtle effect of thymine to be shown. This was not the case under our conditions.

Results and Discussion

Our data indicate that thymine has no curative or preventive effect on the course of folic acid deficiency in the rat with respect to either growth or any part of the blood picture, when it is fed daily in amounts equivalent to 2.1, 3.5, 4.2, and 7.2 γ of folic acid as determined microbiologically in our laboratory.[3]

In view of the striking observations reported by Spies, *et al.* in human patients (*5*), these results on rats are interesting. They point to the fact that thymine is not a true substitute for folic acid and indicate that when folic acid-like activity is shown by thymine, pyrimidines, or other preparations, some indirect mode of action must be operating. Such a viewpoint is in harmony with the fact that thymine is chemically very unlike folic acid.

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Experimental Diabetes and Diet

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The influence of different diets on sensitiveness to alloxan and experimental pancreatic diabetes in the white rat has been investigated.

Two hundred twenty-three female rats weighing between 90 and 120 grams were divided into several groups and fed different diets for a period of one month. At the end of the month and 12 hours after the last meal they were injected intraperitoneally with 160 mg./kg. of alloxan. The mortality rate was considered during one week after the injection, and in all cases high hyperglycemia preceded death.

The results were as follows (see Table 1):

(1) In the group given a high carbohydrate diet the mortality due to alloxan was 40 per cent.

(2) In the group given a low protein diet (10 per cent casein content) there was 90 per cent mortality. Increasing the protein content from 20 to 45 per cent increased the resistance to alloxan (40 and 33 per cent mortality).

TABLE 1

Diets	Wheat flour (%)	Corn flour (%)	Casein (%)	Fat (%)	Yeast (%)	Cod liver oil (%)	Salt mixture (McCollum Davis) (%)	No. of rats used	Mortality (%)
(a) High carbohydrate	35	34	20	0	5	5	1	15	40
(b) High protein	10	34	45	0	5	5	1	15	33
(c) Low protein	40	39	10	0	5	5	1	15	90
(d) High lard	10	25	20	34	5	5	1	20	100
(e) High lard and high protein	14	15	30	30	5	5	1	15	100
(f) High ox fat	10	25	20	34	5	5	1	14	86
(g) High lard, and methionine (200 mg./kg./day)	10	25	20	34	5	5	1	10	30
(h) High lard, and sulfanilamide (250 mg./kg./day)	10	25	20	34	5	5	1	10	90
(i) High lard, and choline (300 mg /kg./day)	10	25	20	34	5	5	1	15	100
(j) High lard, and thiouracil (200 mg./kg./day)	10	25	20	34	5	5	1	10	10
(k) High olive oil	10	25	20	34	5	5	1	15	40
(l) High butter	10	25	20	34	5	5	1	15	33
(m) High oleomargarine	10	25	20	34	5	5	1	15	21
(n) High corn oil	10	25	20	34	5	5	1	15	13
(o) High coconut oil	10	25	20	34	5	5	1	14	0
(p) High lard (30%) and coconut oil (10%)	9	20	20	40	5	5	1	10	20

(3) High lard and high ox fat diets decreased strongly the resistance to alloxan (100 and 86 per cent mortality, respectively). This effect was not modified in the former either by increasing the casein content from 20 to 30 per cent (100 per cent mortality) or by treatment with choline or sulfanilamide. In contrast, the treatment with methionine or thiouracil corrected the hypersensitiveness (30 and 10 per cent mortality, respectively).

(4) The sensitiveness to alloxan was not modified when high olive oil or high butter diets were administered (40 and 33 per cent mortality, respectively), but there was an increased resistance to alloxan in the rats fed either a high oleomargarine diet (21 per cent mortality) or in those fed a high corn oil diet (13 per cent mortality).

(5) Complete protection to alloxan in rats fed a high coconut oil diet (0 per cent mortality) was observed.

(6) In rats fed a high lard diet modified by the addition of 10 per cent coconut oil, a partial protection to alloxan was observed (20 per cent mortality).

The role of the quality of diets and the amount of food fed on the initiation and evolution of experimental pancreatic diabetes in rats has also been studied.

Fifty-one male rats weighing about 130 grams were subtotally pancreatectomized (95 per cent of the pancreas) and divided into three groups, each of which was fed one of the diets shown in Table 1 (a, b, and d).

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[3] The thymine used in this work was chemically pure and found to have 200 γ of folic acid activity/gram.

As shown in Table 2, the high protein diet showed a protective effect and the high lard diet an unfavorable effect in comparison with that which was high in carbohydrate.

TABLE 2

Time after operation (mos.)	High protein diet		High carbohydrate diet		High fat diet	
	Diabetes		Diabetes		Diabetes	
	Total	%	Total	%	Total	%
1	4/16	25	2/18	11.1	7/17	41.1
2	9/16	56.2	14/18	77.7	17/17	100
4	10/16	62.5	15/17	88.2	15/15	100
5	10/16	62.5	12/13	92.3	15/15	100
6	11/15	73.3	11/12	91.6	14/14	100
7	11/15	73.3	11/11	100	10/10	100
8	9/12	75.0	10/10	100	5/5	100

In overfed rats (fed three times daily with a high carbohydrate diet) the evolution of diabetes was much faster than in those fed once a day and eating less food. Furthermore, the same diet but restricted in quantity (about 80 per cent of the amount of food eaten by a normal rat) produced a marked delay in the time of initiation of diabetes (see Table 3).

TABLE 3

Time after operation (mos.)	Underfed		Overfed		Ad libitum	
	Diabetes		Diabetes		Diabetes	
	Total	%	Total	%	Total	%
1	1/13	8	4/17	23.5	2/18	11.1
2	5/12	41.6	15/15	100	14/18	77.7
4	3/7	42.8	10/10	100	15/17	88.2
5	1/7	14.3	7/7	100	12/13	92.3
6	4/7	57.1	5/5	100	11/12	91.6
7	3/7	42.8	3/3	100	11/11	100
8	3/7	42.8	3/3.	100	10/10	100

Diabetes appeared first in those rats which received their food once a day (in a quantity proportional to their body weight) rather than in those receiving the same amount of food divided into three feedings at 7-hour intervals. It may be supposed that the higher postprandial hyperglycemia of the former diet exerts an unfavorable effect, whereas the postprandial hyperglycemia resulting from the latter is less intense.

SUMMARY

In the experiments described the following observations have been made:

(1) The toxic and diabetogenic action of alloxan increases in rats fed a low protein diet and even more so in the case of a high lard or ox fat diet.

(2) The action of these fat diets was corrected by the addition of methionine, thiouracil, or coconut oil, but there was no modification either by addition of choline or sulfonamide or by increase in the protein proportion.

(3) In rats fed other high fat diets (olive oil, butter) the actions of alloxan were not modified, but there was a slight diminution when high oleomargarine or corn oil diets were fed. However, complete protection was observed when a high coconut oil diet was administered.

(4) The unfavorable effect of the high lard diet was observed also on the initiation and evolution of diabetes due to subtotal pancreatectomy. Contrarily, feeding a high protein diet and especially treatment with thiouracil had a favorable effect.

(5) Diabetes appeared first in subtotal pancreatectomized rats which were overfed, then in those which ate ad libitum, and finally in those which were underfed. Diabetes appeared in rats fed a single meal before it did in those eating the same amount of food divided into three meals.

Mechanism of the Antibiotic Action of Certain Quinones

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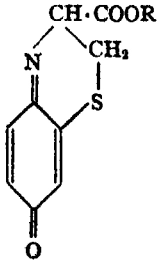
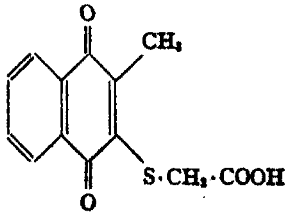
A widely accepted theory suggests that many antibiotics function chiefly because of their ability to interfere with the sulfhydryl groups of enzymes concerned in bacterial metabolism (*2*).

In a recently published report by Colwell and McCall (*3*) it is claimed that the inhibition of bacterial and fungus growth by 2-methyl-1,4-naphthoquinone and related quinones also is due to a reaction of the quinones with sulfhydryl compounds. This theory is supported by the fact that excess amounts of sulfhydryl compounds are able to suppress the antibiotic properties of 2-methyl-1,4-naphthoquinone. Kuhn and Beinert (*8*) have shown that p-benzoquinone and cysteinethylester-hydrochloride react by addition of the —SH compound to a free position in the quinone molecule; in two further steps a condensation product (I) is formed. Fieser and Fieser (*4*) describe the reaction between 2-methyl-1,4-naphthoquinone and thioglycolic acid, where an addition product of the formula (II) is formed.



(I)



(II)

As far as quinones are concerned, the theory described is, however, not a satisfactory one. As Colwell and McCall (*3*) state, it does not explain the antibacterial and antifungal potencies of 2-methyl-3-methoxy-1,4-naphthoquinone, because this quinone has no free position on the quinone side of the molecule. Oxford (*9*) has shown that among p-benzoquinone derivatives the spinulosin-trimethylether (trimethoxytoluquinone) is one of the strongest bacteriostatics of this group; certainly, no possibility of addition exists in this compound. The effect of excess amounts of sulfhydryl compounds on the bacteriostatic potency of some quinones does not prove conclusively the existence of a specific antagonism between quinones and —SH groups. The inactivation of the quinones can be achieved by excess amounts of other strongly reducing substances (e.g. sodium bisulfite) as well.

Quinones are very reactive substances. In experimental work done in this laboratory (*6*), the inhibitory potency of many quinone derivatives on some enzyme systems (urease, papain, catalase, etc.) was tested. It was found that some of the very strongest antibiotics had no, or nearly no, effect on the activity of these enzymes. In the case of urease and papain, certainly —SH groups, which function as activating groups for the enzymatic process, are involved. A certain parallelism between antibiotic properties and inhibitory potency on urease and papain should be expected, if really the reaction with sulfhydryl compounds would be the dominant mechanism of the antibiotic action. By the same experiments it was shown that some enzymes, in which certainly no sulfhydryl groups play any role, also are inhibited by quinones. Of course, the inhibition of enzymes without —SH groups also could be one of the means by which the quinones exert their antibiotic effects. It is also known that quinones can react with amino groups of proteins and amino acids; the tanning properties of p-benzoquinone are used in industry to a certain extent (*5*). It could be imagined that, by tanning the protein compounds of the bacterial cellular membranes, normal cell division could be inhibited. Another possible mechanism can be derived from the relatively elevated oxidation-reduction potential of most of the quinones. Wieland (*10*) has demonstrated that p-benzoquinone is a strong inhibitor of some dehydrogenases. Thus, quinones could act as antibiotics by interfering with bacterial respiratory enzymes and thereby inhibit the synthesis of essential cell components.

The theory that the mode of antibiotic action of the quinones is a complex one can be supported by the fact that some of the quinones with strongest bacteriostatic potency on *Staphylococcus* have very little effect on *Escherichia coli* or on some species of yeast as *Saccharomyces cerivisiae* or *Torula utilis* (*7*), while other quinone derivatives, whose toxicity on *Staphylococcus* is quite negligible, exert rather strong effects on the other organisms mentioned. In experiments with *Planaria gonocephala* we were able to show that, using one compound, it was possible to distinguish two different dominant factors, progressing from higher to lower concentrations of the toxic agent. The data obtained lead us to believe that the effect of higher concentrations of the quinones is dominantly due to the tanning property of these compounds, while in lower concentration the quinones exert their antibiotic effects by the inhibition of some enzyme of the organism, most probably some of the oxidative-reductive enzymes.

The experiments mentioned suggest clearly that the antibiotic action of the quinones is not due to a single reaction, but to a very complex mechanism. The mode of action proposed by Colwell and McCall is certainly only one of the means by which the quinones exert their effects and, in most cases, seems not to be the dominant one.

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Virus Hemagglutination[1]

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The phenomenon of virus specificity is a familiar biological problem, but, with the possible exception of the bacteriophage group of viruses, the nature of the factors responsible for this specificity has not been clearly defined. With respect to the bacteriophage there is evidence that the virus unites with a specific component on the cell—in the case of *coli* and coliphage, for instance, with an antigenic surface polysaccharide (*5*). In the animal virus group, Curnen and Horsfall have shown that the P.V.M. virus can unite with some cellular component of lung tissue (*2*). The combining material was described as tissue particles.

It is evident that accurate characterization of the specific combining tissue components, especially with respect to their structural chemistry, might lead to an understanding of virus specificity in terms of chemical or metabolic relations between the virus and cell. In this connection it was thought that one possible approach to the problem would be the elucidation of the factors responsible for the hemagglutination phenomenon first described by Hirst (*3*) and studied further by Burnet, McCrea, and Stone (*1*) with respect to the alteration of cell receptors by virus action. The results of some preliminary studies along these lines are the subject of this communication.

From red blood cells[3] which are specifically agglutinated by certain viruses it has been found possible to prepare lipid extracts capable of inhibiting the hemagglutinating action of the same viruses for these cells. The effect is presumably due to competitive combination of the extract with the virus. Comparison of Rows 4, 5, 7, and 8 with 1 and 2, and Rows 17 and 18 with 13 and 14 in Table 1, indicates the extent of inhibition in a typical experiment. In these experiments 0.2 cc. of saline emulsion of the inhibiting material was mixed with serial dilutions (0.2 cc.) of allantoic fluid of chick embryos infected with virus, and the mixture was allowed to stand at 2° C. for 30 minutes. One-tenth cc. of 2.5 per cent suspension of red cells was then added, the mixture was thoroughly shaken, and the cells were allowed to settle. The degree of agglutination was read by the method of Salk (*6*).

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[1] *Aided by a grant from the National Foundation for Infantile Paralysis, Inc.*

[2] Fellow of National Health and Medical Research Council of Australia.

[3] Human red cell residues from plasma fractionation were kindly supplied by the Antitoxin and Vaccine Laboratory, Massachusetts Department of Public Health.

TABLE 1

Row	Virus	Inhibitor source	Red cells	Dilution of virus								
				1/1	1/2	1/4	1/8	1/16	1/32	1/64	1/128	1/256
1	Mumps	Saline	Human	+++	+++	+++	+++	+++	++	–	–	–
2	"	"	Chicken	+++	+++	+++	+++	+++	+++	+	–	–
3	"	"	Sheep	+++	+++	+++	+++	+++	+++	+	–	–
4	"	Sheep R.B.C.	Human	+	+	±	–	–	–	–	–	–
5	"	"	Chicken	+++	+++	+++	+++	+	–	–	–	–
6	"	"	Sheep	+++	+++	+++	+++	+++	+++	+	–	–
7	"	Human R.B.C.	Human	–	–	–	–	–	–	–	–	–
8	"	"	Chicken	–	–	–	–	–	–	–	–	–
9	"	"	Sheep	+++	+++	+++	+++	+++	+++	–	–	–
				1/25	1/50	1/100	1/200					
10	"	Sheep #2	Sheep #2	+	–	–	–					
11	"	Human	Sheep #2	+	–	–	–					
12	"	Saline	Sheep #2	+++	+++	+	–					
				1/1	1/2	1/4	1/8	1/16	1/32	1/64	1/128	1/256
13	PR 8	Saline	Human	+++	+++	+++	+++	+++	+++	+++	+++	+
14	"	Saline	Chicken	+++	+++	+++	+++	+++	+++	+++	+++	+
15	"	Sheep R.B.C.	Human	+++	+++	+++	+++	+++	+++	+++	+++	–
16	"	"	Chicken	+++	+++	+++	+++	+++	+++	++	++	+
17	"	Human R.B.C.	Human	++	±	–	–	–	–	–	–	–
18	"	"	Chicken	–	–	–	–	–	–	–	–	–

The inhibition reactions thus far tested seem to demonstrate specificity corresponding to that shown by the viruses in their hemagglutinating actions. Thus, it is known that influenza virus will agglutinate human and chicken red blood cells, but not sheep cells, whereas mumps virus will agglutinate human, chicken, and sheep red cells. Assuming structural similarity or identity between the cell receptor and the inhibitor molecule, it would then be expected that human inhibiting extract would be active against both influenza and mumps viruses, but that sheep inhibitor would only be active against mumps virus and inactive against influenza virus. Corresponding to these expectations it was found that human inhibitor prevented the hemagglutinative action of influenza on both human and chicken red cells (compare Rows 17 and 18 with 13 and 14 in Table 1), whereas sheep inhibitor had no effect on the influenza virus (compare Rows 15 and 16 with 13 and 14). On the other hand, both human and sheep inhibitors interfered with the action of mumps virus[4] on human and chicken cells (compare Rows 7 and 4 with 1 and Rows 8 and 5 with 2). Both human and sheep inhibitors also interfered with the action of mumps virus on sheep cells, but this effect was often weaker and not obtained as invariably as were the other inhibitory effects (compare Rows 9 and 6 with 3, and Rows 10 and 11 with 12).

TABLE 2

Time of contact before removal of aliquot	Final dilution of virus							
	1/2.5	1/5	1/10	1/20	1/40	1/80	1/160	1/320
1 min.	–	–	–	–	–	–	–	–
30 "	+	–	–	–	–	–	–	–
60 "	++	–	–	–	–	–	–	–
120 "	++	+	–	–	–	–	–	–
240 "	+++	++	+	±	–	–	–	–
Virus at room temperature 4 hrs.	+++	+++	+++	+++	+++	+++	++	–
Inhibitor at room temperature 4 hrs.	–	–						

+ = agglutination.

On prolonged contact of virus and inhibitor at 25° C. or 37° C., interaction between the two resulted in progressive inactivation of the inhibitor, evidenced by reappearance of increasing hemagglutinative activity in an inactive mixture (Table 2). In this experiment influenza virus and human inhibitor were mixed and allowed to stand at room temperatures. Aliquots were removed at various intervals, serially diluted, and tested for hemagglutinating activity on human cells. The results are reminiscent of Hirst's description of reversal of hemagglutination (*4*) of cells, accompanied by elution of active virus and loss of cell susceptibility to further agglutination by the same virus. This similarity lends further support to the notion that the inhibitor is a derivative of, or identical with, the cell receptor. Influenza inhibitor has also been obtained from human lung.

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[4] Egg adapted strain kindly supplied by J. F. Enders.

Further details of this work and other related aspects of the problem, now under investigation, will be the subject of later communications.

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Reconsideration of the Photosynthetic Mechanism in *Chlorella*[1]

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Photosynthesis has been classically identified with the formation of carbohydrate. Theories of photosynthesis have frequently postulated a series of photochemical steps operating at all levels of reduction from carbon dioxide to carbohydrate. An a priori assumption in all such theories is that some form of carbohydrate is the direct product of the photochemical reactions. This viewpoint is consistent with data on photosynthesis in higher plants. For example, the elemental analysis of a corn plant indicates that its dry weight corresponds to almost pure carbohydrate (*3*); in short-time experiments on sunflower leaves the carbon dioxide taken up can be recovered quantitatively as carbohydrate (*6*).

Because of experimental advantages the green alga, *Chlorella pyrenoidosa*, has found wide use in studies on photosynthesis. No fundamental differences have been found between its photosynthetic behavior and that of higher plants. However, elemental analysis of the dry material of *Chlorella* is quite different than that of a higher plant, *i.e.* the nitrogen content is 8–10 per cent. As in the closely related colorless alga, *Prototheca* (*1*), the cell constituents may be considered to be about half protein and half carbohydrate. In close approximation, all the products of photosynthesis result in cellular materials. It follows that in a growing culture of *Chlorella* protein and carbohydrate syntheses must proceed at about equal rates.

The rapid synthesis of proteins (or other nitrogenous compounds) is borne out by studies of the assimilatory quotient as affected by the source of nitrogen supplied (nitrate or ammonium ion). Data obtained in manometric experiments by the usual procedures are summarized in Table 1.

The assimilatory quotient is affected by the light intensity during measurement as well as by the nitrogen source. The effect is correlated with the following observations. Up to ~ 50 f.-c., rate of growth is proportional to light intensity and to the measured rate of gas exchange. At higher light intensities (e.g. ~ 600 f.-c.) the cells may show a much higher rate of gas exchange, but they do not grow any more rapidly than at 100 f.-c. (*4*). Although complete explanation of these phenomena is not yet available, it appears to be related to differences in the comparative rates of carbohydrate and protein syntheses which depend upon light intensity and the previous history of the cells. Discrepancies between the quotients reported here and those found by other workers may be explainable in the same way.

TABLE 1

Assimilatory Quotient (CO_2/O_2, Exchange Ratio) Under Light-limiting and Light-saturating Illumination as Affected by the Nitrogen Source

Nitrogen source	Illumination	
	40 f.-c.	600 f.-c.
NO_3^-	−0.5	−0.8
NH_4^+	−0.9	−0.9

It has already been shown that starved cells of *Chlorella* will bring about an oxidative assimilation of acetic acid or glucose to what appears to be storage carbohydrate (*5*). This means that the processes of dark metabolism are able to effect synthesis of storage materials from respiratory intermediates. The accumulating products of photosynthesis also have been shown to be storage materials (*5*). Growing cells of *Chlorella* require protein and carbohydrate syntheses at approximately equal rates. These syntheses may result either from photosynthesis or from oxidative assimilation of an organic substrate in the dark. It is certainly reasonable to expect similarities in the pathways of the two modes of synthesis. We therefore offer, and shall further investigate, the following hypothesis: In photosynthesis the photochemical product is some intermediate, not itself carbohydrate, which may be converted subsequently to carbohydrate or to protein by metabolic pathways similar to those of heterotrophic forms.

We are well aware that this hypothesis has certain relations to, and apparent conflicts with, other theories and experimental data (e.g. *2*). There are also important implications of the low quotient at low light intensities with regard to past measurements of photosynthesis, in which a quotient of −0.9 has often been assumed. Experimental details, more complete data, and a consideration of their implications, will be reported elsewhere.

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[1] Supported by a grant from the University of Texas Research Institute.

IN THE LABORATORY

Methods for Increasing the Value of Hydra as Material in Teaching and Research

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In the course of an investigation in which *Hydra fusca* was used it became necessary to secure known and controllable environmental conditions in which the organism would exhibit normal behavior. This necessitated discarding the usual "pond water" and substituting a known solution as the environmental fluid. During the progress of trials to this end certain observations were made which may prove of use in facilitating classroom culture of, and demonstrations with, this form and also in enhancing its value as experimental material.

Hydra from cultures collected locally or from cultures obtained from Woods Hole, when transferred to a saline solution[1] made with ordinary distilled water from the laboratory supply, went into "depression" (*i.e.* exhibited continuous contraction followed by loss of tentacles, leading often to final disintegration), beginning a few minutes after transfer.

If distilled water of great purity, triple distilled from glass, was used, this did not occur, and the hydra remained normal. Neither did it occur immediately if a small amount of the culture fluid was added to the saline made with the ordinary distilled water. However, the addition of crystalline egg albumin, at the rate of 0.2 cc. of a 3 per cent albumin solution/100 cc. of the saline, was found to give complete protection for several days (3 at least), under survival conditions.

Experiments indicate that the toxic action of the water is probably due to substances such as traces of heavy metals, which are effective in extremely low concentration. Copper was found to be toxic within a few hours when present in a molar concentration of 5×10^{-7}. The action was completely prevented by albumin at 1:50,000, possibly even less. Tests indicate that this protective action is most probably the result of removal of the toxic material by adsorption on, or combination with, the albumin.

Hydra in solutions containing sufficient albumin show very fully stretched bodies with the tentacles extended to their maximum length, giving a display seen only rarely.

While the foregoing treatment will eliminate the need for exceedingly pure water in making cultures or class demonstrations, it was realized that a preparation of crystalline egg albumin is not readily available to all, so a few experiments were tried using filtered egg white. This will serve for classroom use. The amount needed will have to be ascertained by trial and error.

It is not necessary, at least over periods of a few hours, to use a saline solution. Distilled water shaken with a little egg white will serve to maintain the exhibition.

Another demonstration readily made under these conditions is vital staining with methylene blue. It was found that by increasing the concentration of albumin the toxic action of the dye was so reduced that deeply stained specimens showing little, if any, symptoms of damage could be made. For this the albumin concentration should be increased about 5-fold. A solution of the dye of 1:30,000 is tolerated. If, after staining, the hydras are kept for 12 hours in a solution lacking the dye, all the dye will be found in the endoderm, leaving the ectoderm colorless except for the cnidoblasts. These show as minute, dark blue dots.

Hence, by the use of these simple techniques, classroom cultures may be kept more easily, and demonstrations of the phenomenon of depression, recovery therefrom, the beauty of the fully extended animal, and the tissue layers may be easily made in the living state.

The ability to keep hydra in good condition in a known environmental medium will greatly increase its value as research material.

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[1] The saline contained KCl, 0.002 gram; NaCl, 0.05 gram; $CaCl_2$, 0.003 gram; and $NaHCO_3$, 0.002 gram/1,000 cc. distilled H_2O.

Electron Micrographs of X-Ray–treated *Escherichia coli* Cells

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Ever since Muller (*14*) produced mutations in *Drosophila* by X-rays, this method has been adopted in the study of mutations in many other organisms, including microorganisms. Beadle's work (*1*) on X-ray mutants of *Neurospora* has not only given us many new ideas of the metabolism of this fungus, but it has also been a contribution to fundamental ideas of genetics. Euler, Ahlstrom, and Hogberg (*5*) X-rayed yeast cells to produce genetic changes, including formation of giant cells.

FIG. 1. X-ray-treated *E. coli* cell which has become elongated (ordinary microscope).

The effect of X-rays on bacteria has been studied by a number of investigators since shortly after Roentgen's discovery of the rays. Newcomer (*15*) in 1917 noticed that X-rays had a bactericidal effect on *Eberthella typhosa*. Clark and

Boruff (*2*) measured the lethal effect on *Bacillus coli* and *Erythrobacillus prodigiosus*, as well as destruction of the ability of the latter to produce the characteristic red pigment. Drea (*4*) attenuated *Mycobacterium tuberculosis* by the use of X-rays. Several geneticists, including Demerec (*3*), have used X-rayed bacterial cells in their studies on the phenomenon of mutation.

FIG. 2. X-ray-treated *E. coli* cells which have become elongated (ordinary microscope).

Lincoln and Gowen (*13*) studied several mutations produced by X-rays in *Phytomonas stewartii*. Haberman and Ellsworth (*8*), in a similar investigation on *Staphylococcus aureus* and *Serratia marcescens*, noticed the formation of elongated cocci into chains, instead of the usual grape-like or packet groupings.

It has been observed, in X-ray-treated bacteria, that the organisms sometimes lose their ability to multiply but are not dead. As early as 1917, Kempster (*10*) noticed that his X-rayed bacilli were not destroyed, although they failed to multiply. Often, these X-rayed bacteria which have lost their ability to multiply continue to grow into unusually elongated cells. Lea, Haines, and Coulson (*12*) made a careful study of these giant bacteria, and Evelyn Wilkin (*17*) observed the phenomenon in her mutation studies of *E. coli*. Explanations for cell elongation after irradiation, without division, are offered by Hollaender (*9*), Rahn (*16*), and Lea, Haines, and Bretcher (*11*).

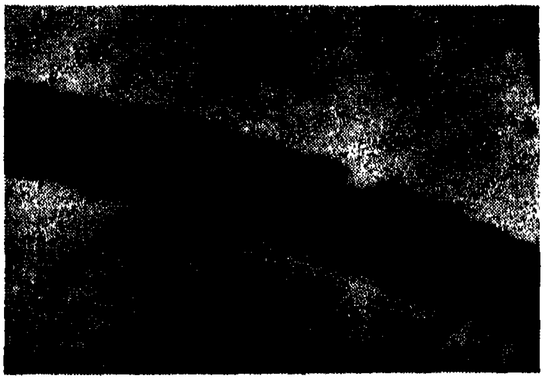

FIG. 3. Section of X-ray-treated *E. coli* cell which has become elongated (electron micrograph). Note mottled appearance.

Gray, Marton, and Tatiun (*7*), who made an electron microscope study of X-ray-produced mutants of *Acetobacter*, observed bulges in the mutants, which they interpreted as high concentrations of nucleoprotein.

The purpose of our investigation was to examine these irradiated, elongated cells under the electron microscope and study the ways in which they might differ from normal bacterial cells. Irradiation at 50 kv. and 20 ma. produced the irregular morphology. Figs. 1 and 2 show elongated *E. coli* cells as they appear under the ordinary microscope. Except for the elongation, the appearance is the same as that of the normal cell. However, under the electron microscope, the elongated cells show characteristics not observed in the normal cell. As may be seen in Figs. 3, 4, and 5, some of these cells have a definitely mottled and irregular appearance, certain

FIG. 4. Section of X-ray-treated *E. coli* cell (electron microscope). Note irregular appearance.

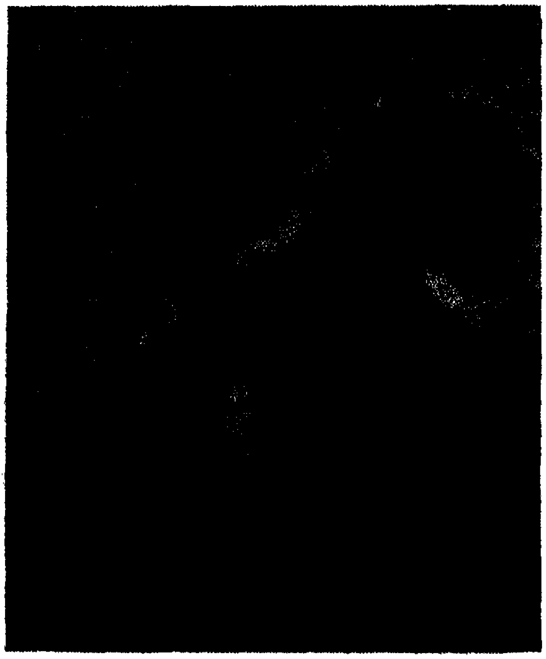

FIG. 5. X-ray-treated *E. coli* cell (electron microscope). Note irregular appearance.

areas being less dense than the remainder of the cell. In Fig. 6, which shows parts of the same cell, another unusual feature may be seen. Some of the elongated *E. coli* show definite "breaks" in the cell, perhaps at the place where the cell would have divided normally. Gates (*6*) reported that his irradiated bacteria broke up into units, which then degenerated without further growth. Fig. 6 may be an indication of this type of behavior.

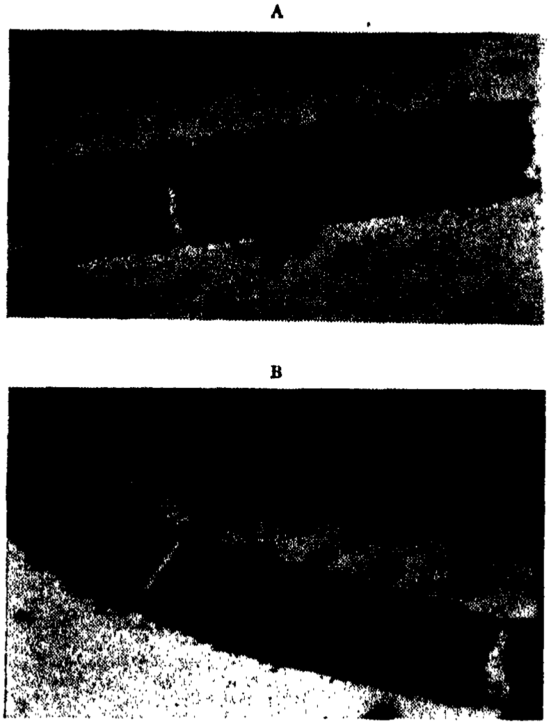

FIG. 6. A: X-ray-treated *E. coli* cell (electron microscope). Note periodic "break" in cell; B: part of same cell.

A possible explanation for "breaks" in the cell is that the enzyme which is responsible for the pinching off of the cell wall in normal bacterial fission has been destroyed by X-rays while other enzyme systems continue to function.

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A Mirror Device for Studying Lower Surfaces of Small Objects Using a Dissecting Microscope

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The problem of viewing all sides of a minute object such as a small flower, a small insect, and the like can often be not only difficult but exceedingly exasperating. The writer has for some time been studying a group of plants, the flowers of which are not over 3 mm. in size. A binocular microscope was necessary for accurate study of these. In order to count parts, observe arrangement, etc., it was necessary, after observing the upper surface, to turn the flower over painstakingly for a view of the lower surface. This method was very unsatisfactory because of time wasted, the possibility of losing the object, and the uncertainty arising from inability to see the entire object at the same time.

Recently, however, a solution to this problem has presented itself and is described here with the hope that it may be of use to other workers faced with similar problems. The device is quite simple and can be constructed in a few minutes by anyone. The model which has been used by the writer (Fig. 1) consists of a piece of plate glass, ⅝ inch thick, mounted on top of a small mirror. This is placed on the stage of a binocular dissecting microscope, and the object to be viewed is placed on top of the glass plate. The lower surface may be seen by merely focusing toward the object a distance equal to slightly less than twice the thickness of the glass used. This action brings the image of the lower surface distinctly into view, and the results are the same, regardless of the magnification used. In the present model a millimeter scale has been slipped between the mirror surface and the plate glass, but a scale,

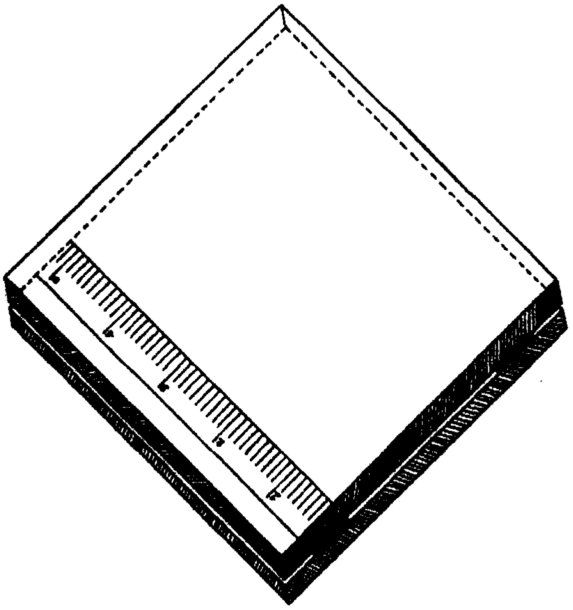

FIG. 1

scratched or etched into the glass itself, might be more useful. A strip of material of the same thickness as the scale was placed between the mirror and the glass on the side opposite the scale. This was necessary to offset the tilting effect of the scale.

Glass of a thickness less than that specified above may be used, but with thinner glass the image of the lower surface is not perfectly clear, and only small objects (1-3 mm.) may be studied. If the ⅜-inch glass is used, the image of the lower surface is as clear as that of the upper. The use of the thicker glass also permits the study of objects up to about 5 mm. in size.

There is also a definite relationship between the distance of the light source from the plate glass and the image obtained. The light should be placed 3-4 inches from the plate glass and as directly over the system as the microscope permits for optimum results.

Saturation Concentrations of Triethylene Glycol Vapor at Various Relative Humidities and Temperatures

HENRY WISE[1] and THEODORE T. PUCK

Douglas Smith Foundation for Medical Research and *Bartlett Memorial Fund, University of Chicago;* and *Commission on Airborne Infections, Army Epidemiological Board, Office of the Surgeon General, United States Army*

Recent experiments carried out in this laboratory have indicated the relatively narrow margin which exists between the concentration of triethylene glycol vapor required for optimum bactericidal action and the saturation point of this vapor in air of various relative humidities and temperatures. Although the presence of a mist due to supersaturation with triethylene glycol has been shown to produce no harmful effects on animals living in such atmospheres for long periods of time (2), this condition is undesirable for psychological reasons in situations of human habitat. It becomes important, therefore, to determine the maximum concentration of glycol vapor which may coexist with water vapor in the air, under various atmospheric conditions.

The following communication deals with the measurements of the saturation concentrations of triethylene glycol vapor in the presence of water vapor over a range of temperature extending from 20° to 29°C. Essentially, this problem resolves itself into the study of vapor-phase equilibria in a two-component system composed of triethylene glycol and water. If each component of this mixture obeyed Raoult's law, the equilibrium concentration of the glycol vapor at a given temperature would diminish linearly with an increase in the water vapor concentration, as shown by the dotted line in Fig. 1. However, the chemical nature of the two compounds suggests that their solutions would exhibit deviations from ideal behavior. Such deviations from Raoult's law have been confirmed by the experimental measurements here presented.

A complete description of the apparatus and experimental technique will be presented in a forthcoming publication. The experimental procedure involved an adaptation of the principle of the condensation method recently developed for the determination of vapor pressures of pure liquids (*1*), which permits determination of the equilibrium compositions of the vapor in multicomponent mixtures. Each component of the mixture (in this case, triethylene glycol and water) is independently vaporized at a constant rate into a stream of inert gas (dry nitrogen), which carries the vapor mixture to a highly polished condensation surface thermostatically maintained at the desired equilibrium temperature. The formation and disappearance of a condensed film on this target serves to indicate whether the composition of the vapor mixture corresponds to supersaturation or undersaturation at the temperature of the target. The ratio of the vapor densities of the two com-

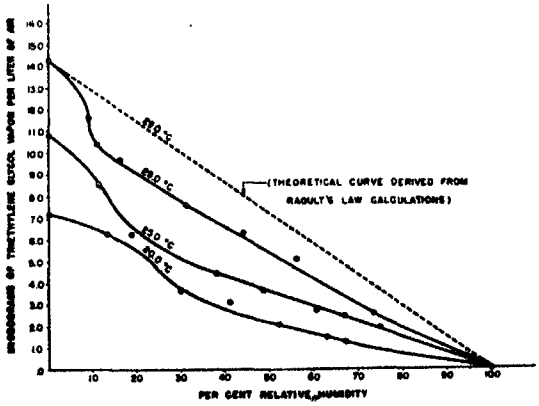

FIG. 1. Saturation concentrations of triethylene glycol vapor as a function of the relative humidity, at three different temperatures.

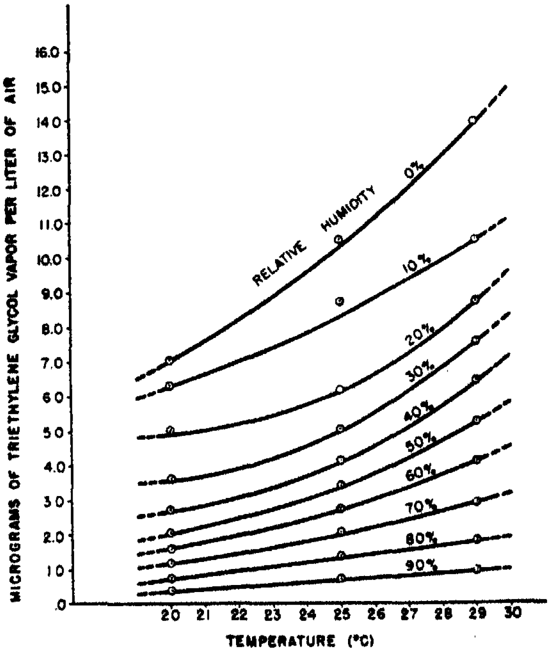

FIG. 2. Saturation concentrations of triethylene glycol vapor at various relative humidities for temperatures from 20.0°C. to 29.0°C.

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[1] Present address: National Advisory Committee for Aeronautics, Cleveland, Ohio.

ponents in the gas stream is progressively varied by adjustment of the rate of flow of diluent gas until the equilibrium composition is attained. This can be done with a high degree of precision, since the equilibrium point can be approached from both sides, *i.e.* by determining the composition at which a condensate first forms on the target, as well as the point at which a film previously formed is removed by a more dilute gas mixture. This critical point, at which a condensate barely begins to form or, once deposited, barely begins to disappear, represents the equilibrium condition for the binary vapor mixture at the temperature of the condensation surface.

By means of this experimental technique the vapor-phase equilibria have been determined at three temperatures (Fig. 1). The graphical presentation of these results, with the marked deviations from a straight-line relationship, indicates that at any relative humidity the saturation point is reached with glycol vapor concentrations well below the theoretical value based on Raoult's law.[2] The area under each curve represents an isothermal region in which glycol vapor and water vapor can coexist in the air without formation of an aerosol. Conversely, any concentration above each curve identifies an atmosphere supersaturated with the vapor mixture.[3] The relative saturation of the air with glycol vapor will therefore be a function not only of relative humidity but also of temperature. A rise in temperature from 20° to 29°C. at 50 per cent relative humidity will more than double the capacity of the air to hold triethylene glycol vapor. A similar effect may be achieved at a constant temperature of 25°C., for example, by lowering the relative humidity of the air from 50 to 16.5 per cent. The accuracy of the experimental results is approximately ± 3 per cent.

By interpolation, the saturation concentrations for intermediate temperatures may be computed from the experimental results obtained at the three temperatures indicated. The temperature coefficient throughout this region is best calculated by means of the Clausius-Clapeyron equation. For pure triethylene glycol, the equation obtained is $\log_{10} P = \frac{-3,170}{T} + 7.758$, where P is the vapor pressure in mm. Hg and T is the absolute temperature. The partial pressure of triethylene glycol vapor at various relative humidities can be computed for intermediate temperatures by means of this equation, or a graphical interpolation may be employed. Fig. 2 presents the results of such an interpolation.

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[2] It should be noted, however, that for this type of graphical presentation, positive and negative deviations from the straight line do not indicate the sign of the deviations from Raoult's law.

[3] Under natural conditions, the critical concentration at which an aerosol begins to form will also be affected by the number and type of condensation nuclei present in the air.

Book Reviews

The operculate land mollusks of the family Annulariidae of the Island of Hispanola and the Bahaman Archipelago. Paul Bartsch. (U. S. National Museum Bull. 192.) Washington, D.C.: Government Printing Office, 1946. Pp. iv + 264. (Illustrated.) $.75.

This taxonomic treatise on the pomatiasid operculate land snails of the islands of Haiti and the Bahamas categorically divides their shells into 24 genera, and "*Incertipoma*," which is "a catch-all for all annulariids that cannot be definitely assigned to their proper genus" and which includes 11 new species. The major groups are founded mainly on the structures of the opercula, which, according to the descriptions, show remarkably little variation inside each genus. Of the 24 genera, 16 are new (and one renamed); of the 17 subgenera, 8. Of 194 species, 117 are described as new; of 96 subspecies, all but 6. In general, the dimensions of only the type shell are given, without specification of sex, although the pomatiasid males are much smaller than the females, and usually little intergradation in shell size is found on examination of the animals. Occasional notes on habitat are included. One of the most notable species is *Sallepoma mutabile* Bartsch, which is omitted from the key to the species in this new genus because its range of variation covers all the differences used for the demarcation of the other species (with the possible exception of its sutural characters, which are not described). The shells of practically every species and subspecies are illustrated by excellent photographs. The taxonomic index is apparently very complete.

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Performance records of individual trees and clones of Cinchona in Guatemala. John R. Shuman. Pp.: text, 4; Tables, 80. (Tabulation filed with Library, U. S. Department of Agriculture, 1947.)

Along with the procuring of cinchona bark in Latin-American countries during the war, great efforts have been made by public agencies, as well as by private Cinchona growers, toward the permanent re-establishment of quinine in the Western Hemisphere. The numerical results of a three-year study on the performance of individual trees and clones of Cinchona in Guatemala are made available to those interested in its commercial cultivation through this tabulation, which is being filed with the Library of the U. S. Department of Agriculture in Washington, D. C. It is the purpose of this review to bring this summary, which represents the largest tabulation of clonal performance records of Cinchona in the world, to the attention of all interested agencies, private as well as public. The final, bound, International Business Machine tabulation is in book form.

A general idea of the scope of this work is obtained from the following summary of data represented:

Data collected and analyzed in Guatemala, C.A.: March 1943–July 1944.

Further analysis of variance of data in U.S.A.: October 1944–March 1945.

Number of chemical assays in data: 3,573.

Number of grafts attempted during 1937–42, inclusive: over 180,000.

Number of grafts set out in the field for same period: 27,531.

Number of trees one or more years in the field and included in the study: 31,058.

Number of trees measured from 1 through 7 years of age, inclusive: over 17,000.

Number of clones: 709.

Number of additional different pedigrees represented by individual trees: 1096.

Number of principal *fincas* where most of plant material is growing: 7.

Number of fields represented in above *fincas*: 27.

Range of elevations of fields: 3,000–6,000 feet, or 914–1,829 meters.

Total area in study: 35.2 acres, or 14.2 hectares.

A total of 709 clones, already established in Guatemala through grafting, together with the individual trees that were assayed but not grafted at 7 principal *fincas*, or estates, represents the material of the clonal performance records. On the basis of these it is possible for the first time to see what has been done with respect to each pedigree and clone and to make certain comparisons. The information given for each pedigree may be classified as follows: (1) identification and description by pedigree; (2) chemical analysis of bark with additional pertinent data on factors believed to affect the alkaloid content of a tree; (3) figures concerning the size of the trees, general appearance, abnormalities, and diseases; (4) ability of plants to survive in the field; and (5) data relating to the ease with which the various plants may be grafted.

Three measures of performance have been computed to permit direct comparisons between pedigrees. Differences due to age and certain environmental conditions are equalized in these three figures. The first is termed *quinine value*, a comparative figure adjusted for differences in age and differences due to fields and altitude. This is computed as a per cent of the average content of the three highest assaying types, namely *ledgeriana*, *ledgeriana* hybrid, and hybrid. *Size value*, the second measure, is adjusted for differences due to age and is computed as a per cent of the average of the three types mentioned above plus *succirubra* hybrid. The third figure, *survival value*, which is adjusted for age, number of years in the field, effect of original planting and replanting, is computed in terms of the average per cent survival for the same four types as were used to determine the average size of the trees.

These figures show the *quantitative amount* by which any given pedigree excels the average of all other pedigrees; *i.e.* it is a quantitative means of comparing the ability of a given pedigree to produce quinine with the average ability of all pedigrees. The figures are consequently free of all personal bias or favoritism and reflect the experience gained at 7 different estates, each directed by different individuals. On the basis of the tabulation it is now possible to select those pedigrees which are the best or the worst with respect to quinine content, size, and survival.

The reliability of the data presented is indicated by the number of individuals upon which the many figures are based. In some instances there are evidently too few observations to give any but the most preliminary indications of the true or probable performance of a given clone. Additional sampling will be necessary to determine the usefulness of certain plant material.

The results of a detailed statistical analysis of the data by the author are in the form of a manuscript entitled *Cinchona in Guatemala*. Cinchona growers in Latin America as well as in other countries would greatly benefit by its publication.

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Scientific Book Register

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Shall Biologists Set Up a National Institute?

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THE PUBLIC RELATIONS OF THE biological sciences have been very much neglected, and today these sciences find themselves in much the same plight as did the physical sciences in 1930. The situation of the physicists at that time has been described as follows in a 1942 report of the American Institute of Physics:

> The (American) Institute (of Physics) had its origin in the pressing need for cooperation between the several American societies of physics, which need became apparent in 1930 and 1931 and was increasingly realized in the course of discussions held at that time between officers and committees of these societies. There were then operating these trends:
>
> 1. A notable and gratifying increase in American research activity calling for an increased number of pages in research journals without adequately increased income becoming available to pay the increased costs entailed. The financial condition of the journals was going from bad to worse.
>
> * * *
>
> 2. A growing tendency for physics to "split up."
>
> * * *
>
> No responsible person could contemplate these trends without grave concern. Must the results of research be inadequately reported or be suppressed through lack of funds? Must there be an increasing number of overlapping but unconnected societies for physicists to pay dues to? Would all of the profitable applications of physics appear under some other name, rendering no recognition and no financial support back to the parent science? Did these many groups have no common interests and objectives which they could attain better together than separately?

These words sound strange indeed to one acquainted with the present efficient way in which the American Institute of Physics looks after needs of physics and physicists.

I quote, by permission, from an unpublished paper discussing the present situation of physics:

> In 1931 voluntary officers, with a little secretarial help, could handle the needs of the members of the Societies and also speak for them in external matters. Our membership has since tripled. Our Societies are increasingly active. Moreover, the world has awakened to a recognition of the importance of our field of endeavor. Government agencies, national associations in many fields, the public press, educational institutions, industrial organizations, and others now press us for advice, cooperation, and an expression of the point of view of physics.
>
> Most of the problems presented are general, the interests of our Societies in them are identical and the Institute has come to be recognized as the representative agency to turn to. The future development of physics and the personal careers of physicists will be greatly affected for good or ill by what the Institute does. The load which would now have to be borne by the officers of the Societies, if the Institute did not exist, would be far too great for part-time attention. The harm which would result from uncoordinated and internally inconsistent representation of physics would be great.
>
> A specific example may serve to illuminate these generalized statements. It is important to physics to have a single, strong agency controlled only by physicists, to watch, and on occasion to advise concerning, the formulation of laws to govern the control of atomic energy, to extend federal support to research and education in science, and to provide for science in national defense or in world security. Such an agency is, then, needed vitally to watch, and advise concerning the administration of such laws by Government officials and on occasion to assist in their formulations and execution. With such an agency we can discharge our essential duty to society in these respects and, at the same time, ensure the free and vigorous advance of physics and improve the opportunities and facilities open to physicists for valuable and useful work.
>
> * * *
>
> To cite an example, the Institute made a study of shortages in scientific manpower. It introduced the conclusion into a report by Dr. Vannevar Bush to the President on which proposed legislation for a national science foundation was based, used the same conclusions to liberalize deferments and discharges from the armed services, and played the major role in establishing the pre-doctoral fellowships supported by a $550,000 grant from The Rockefeller Foundation. Only an authoritative, fully representative and efficient agency can hope for continuing success in enterprises of such magnitude.
>
> Such examples of course depict only a small part of the present work of the Institute and, taken alone, are insufficient correctly to represent its character.

We can have similar prestige and opportunity in biology if we will.

One of the most significant features of the change in the situation of physics is that the physical societies have been strengthened, and very greatly strengthened, by the activities of the Institute. That is because something new—something which was not attempted before—has been added. The same strengthening of the biological

This and the two following papers were among those presented before a Symposium on Proposed Plans for Union Involving Workers in the Biological Sciences, Section G, AAAS, Boston, December 27, 1946.

societies will occur if these societies get behind their institute as strongly as the physical societies are behind the Institute of Physics.

LACK OF PUBLIC APPRECIATION OF THE CONTRIBUTIONS OF BIOLOGICAL SCIENCE TO VICTORY

Everyone knows the major contributions of physics to victory—radar and the atomic bomb. But how many know that the contributions of biological science were of comparable importance? A physician with whom I recently talked showed great enthusiasm over the medical advances made during the war. When asked to name the most important, he answered: "Penicillin and DDT." Chemists have also claimed both these products as their contributions. I do not need to tell you that both are contributions of biology! In the research on penicillin and DDT, however, the top men controlling policy and appropriations were not biologists. There was not a single entomologist on the Insect Control Committee. True, biologists were called in as "hewers of wood and drawers of water." They had to be, for they alone were competent.

Failure of biologists to receive recognition for their work should be a matter of public concern, for the cost to this Nation of the absence of biological control over biological operations in the war was great. Rather early in the development of penicillin a biologist sought $20,000 to support research on improved strains of the organism. His application was rejected as impractical by OSRD. Later, WPB authorized this research—but only after expending several hundred thousand dollars on efforts in the same direction—and the productiveness of the organism was doubled. Biologists would have known that it was practical and, if in command, not only would have operated economically but would have made penicillin available to the public a year and a half sooner. No man can guess how many lives would have been saved if that project had gone through promptly.

But penicillin and DDT were not the largest contributions of biology to victory. "Food will win the war and write the peace" was a good and true slogan, though clumsily implemented. We could have won the war without penicillin or DDT, but we could have won neither war nor peace without hybrid corn, improved wheats, and other new varieties of crop plants developed by our plant breeders just in time for war needs. Without these improved crops, this country could not have supplied the food to support our armies, maintain our people at home at an efficiency unmatched elsewhere, and provide at the same time the tremendous stores of food sent to a devastated world.

Last year the United States shipped abroad more wheat than was ever before exported by any country in any year. This year's wheat crop again broke all records for production. In fact, each year since 1937 American food production has topped all previous records. This increased yield has resulted largely from improved varieties, the contribution of the plant breeders. But, for lack of proper advertising, there is little public recognition of the critical importance of the part that plant breeding played in our victory.

In the phrase of the physicists, a large proportion of the contributions of biology appears under some other name and neither renders recognition to, nor brings financial support to, the biological sciences. This is solely because the biologists are not organized so that they can do their job as a group. Until they are so organized, they will continue to work for others. *Biological operations need to be directed by biologists* just as surely as medical care must be directed by physicans.

MISUSE OF BIOLOGICAL MAN POWER IN THE WAR

During the war many strictly biological tasks were assigned to physicians, chemists, and similar personnel, simply because the authorities did not know what biologists could do or where they could be found. At the same time, hundreds of biologists worked under other names than their own. Because the authorities had no comprehension of their own needs from biology, many highly trained men in our fields were assigned low-grade jobs that anyone could have done. This occurred during the same period in which the Services were actively searching for the very men who were being denied the opportunity of using their training in the service of their country.

Bacteriologists in numbers, for example, were being put into the ranks and assigned to kitchen duty at a time when the Army was desperately trying to recruit bacterriologists for special duties—this because there was no national organization able to tell the Army what constituted a bacteriologist and where they could be found and to direct the members of that profession into places where their special skills would be utilized. It is only by such an able, vigilant organization that the Army could be made to see such situations and to provide for its own needs in the way of specialized personnel.

The contrast between the treatment of biologists and that of physicists by the Armed Forces was due to intelligent action by the American Institute of Physics. We need, the country needs, an American Institute of Biology.

When, because of ignorance of the country's real needs, the policies of Selective Service threatened to dissipate the Nation's reserve of scientific men, the National Research Council set up an Office of Scientific Personnel under the direction of M. H. Trytten. This office has been largely responsible for the considerable improvements that have been put into effect in Selective Service and in Civil Service procedures and especially for stopping the drafting of instructors and students in science.

The Office of Scientific Personnel was established through grants from scientific organizations: $3,000 from the American Institute of Physics; $1,000 from the American Mathematical Association; $3,000 from the Geological Society of America. These grants have since been increased in amount, and the Chemical Society and the Psychological Association now also contribute.

When OSP was set up, I was asked: "Which biological society will contribute the additional $3,000 needed?" How would you have answered that? In the end, the National Academy of Sciences put up the biologists' share.

NEED FOR PROFESSIONAL ORGANIZATION OF BIOLOGISTS

Biologists are in a position very similar to that of a man drafted in a war. He may take the course of least resistance and remain a private, taking orders from everybody; or he may, by going to some trouble, become an officer and help to direct the course of events.

The biological sciences have been drafted into the national service. We cannot escape that. We may take command, or we may be commanded and do what we are told whether we like it or not. To take command, we must have an effective organization.

The Magnuson Bill seeking to set up a National Science Foundation made no mention of biology or agriculture except as biologists might be requisitioned into the service of medicine. Biologists of every kind were astonished that the public-spirited framers of a national science bill could be so blind to the Nation's need for biological research. Through the efforts of leading biologists, a division of biology was later included. No one should have been surprised that biology was omitted. Biologists have not made the public aware of the importance of biology.

An example of how self-advertising contributes to the public welfare and to the profession concerned is furnished by the recent rise of psychologists into positions of important public service. It is only within our own time that psychologists themselves have had any idea how useful they could be to a complex civilization.

Correct orientation of our civilization in line with the fundamental biology of ourselves and of the plants and animals with which we work is certainly as important to public welfare as are proper psychological services. Clearly, we must have organization, both to serve public needs and to develop our own professions. What kind of organization should this be? How shall we go about its formation?

A group including the presidents of the Union of Biological Societies and the American Biological Society has done much spade work toward promoting the establishment of an Institute of American Biologists. Their views were ably presented by Detlev W. Bronk to enthusiastic audiences last spring at the AAAS meeting in St. Louis and at the annual meeting of the Division of Biology and Agriculture of the National Research Council. Later, a group of 9 representative biologists requested the Division to survey the general problem. The remainder of this paper constitutes a report of such a survey.

POSSIBLE COURSES OF ACTION

In view of the preparatory work that has been done and the preliminary proposals that have been made for the establishment of an Institute of American Biologists, we face a series of alternatives:

(1) We can agree to set up an institute to serve the combined interests of all the professional people concerned with all of the animal and plant sciences.

(2) We can conclude that the fields of the various biological sciences are too diverse to be covered by any one institute and decide to set up two or more institutes.

(3) We can let this opportunity pass without action.

(4) We can undertake to set up an institute with the support of only a minority of the diverse kinds of biologists. One biological specialty might set up an institute purporting to cover the whole field of biology but really covering only one segment thereof.

For any group to be successful, a minimum budget of $20,000-$25,000 would be necessary. If we assume, as I believe we should, (1) that such organizations should, in the long run, be supported by their members and (2) that $10 per annum is about as much as the rank and file can be expected to pay, it is clear that, for success, groups of at least 2,000 must band together. Groups of 10,000, operating through a centralized administration, would probably be more than five times as strong as groups of 2,000.

The Society of American Foresters and the American Veterinary Medical Association, which alone among our groups have organizations rather closely comparable to the proposed institute, have memberships of approximately 5,000 and 7,500, respectively. The 1944 budget of the former, exclusive of publication costs, was $12,000 and including publication, $31,000; that of the American Veterinary Medical Association, a total of $75,000. The operating budget of the American Institute of Physics in in 1945 was $27,000, and the total was $90,000. This Institute has not, in the past, had individual members. The need of closer contact between the officers and the individual physicists became more and more apparent, and recently action has been taken to add individual members. The membership of its constituent societies totals about 8,000.

CAN THE BIOLOGICAL SCIENCES BE DIVIDED INTO TWO GROUPS?

Many think that biology is too large a field to be included in one institute. Biology covers more ground and comprises more different kinds of scientists than any other major division of science, but examination of the biological sciences makes manifest that they cannot be be dichotomously divided. Table 1 indicates an attempted separation of biological societies into two groups. There are, however, important segments of biology, such as cytology, genetics, and bacteriology, that are working more and more with both plant and animal materials and that cannot be listed under either group. These constitute a third, intermediate group. Let us examine the three groups of biological sciences in detail.

TABLE 1

Plant science societies		Societies looking toward both plant and animal science		Animal science societies		
Society	No. members*	Society	No. members*	Society	No. members*	Members by groups†
Phytopathological Society	1,130	American Genetic Association	3,530	Economic Entomologists	1,500	2,000
Society of Agronomy	1,200	Society of Biological Chemistry	600	Entomological Society	970	
Horticultural Science	740	Ecological Society	740			
Plant Physiologists	640	Genetics Society	560	Society of Mammalogists	950	2,000
Botanical Society	1,380	Society of Bacteriologists	1,500	Ichthyol. & Herpetologists	570	
Mycological Society	380	Development & Growth	250	Limnological Society	380	
Society of American Foresters	4,550			Wildlife Society	900	
Soil Science Society	500			Animal Ecologists	300	
				Physiological Society	770	3,000
				Society of Biological Chemists	600	
				Pharmacol. & Exp. Therapeutics	280	
				Society for Experimental Pathology	290	
				Institute of Nutrition	250	
				Association of Immunologists	250	
				Society of Zoologists	980	
				Society of Parasitologists	520	
				Dairy Science Association	1,350	10,000
				Society of Animal Production	640	
				Poultry Science Association	540	
				Veterinary Medical Association	7,000	
				Livestock Sanitary Association		
Totals	10,520		7,180			17,000

* Numbers are somewhat out of date and are rounded off.

† Numbers are approximate.

I. *Plant science group*. The plant sciences, over 10,000 strong, are a more homogeneous assemblage than either of the others. Yet there is reason to doubt that they would hang together in supporting a single organization.

The foresters (4,550) are already well organized and possibly would not see the advantage of joining with the other plant sciences in an organization whose objectives would be very similar to their own. There is, however, some reason to hope that they would affiliate with an institute speaking more broadly for all the biological sciences. The basis of this statement is the fact that forestry, standing alone, is somewhat isolated. The officers of the Society of American Foresters are, however, keenly aware of changing conditions that make cooperation of the sciences for public service imperative. An institute of biologists could expect the Society of American Foresters to join, but it would not expect a great percentage to take out individual memberships.

The balance of the plant sciences is a more compact and unified group than either the animal sciences or those with affiliation to both animal and plant sciences. Problems of considerable magnitude would be encountered, however, in binding the plant science societies into one unit. As a longtime officer of one of these societies has pointed out, more than one of these groups is essentially dual, comprising at once people whose primary interest is in one of the underlying basic sciences and others whose concern is entirely with practical application.

One might hope that each of the societies would affiliate and that the more scientific members of all of them would join an institute of plant sciences, but few of the more practical people might be expected to come in until the institute had demonstrated its usefulness to them. It would be difficult to guess how many members a plant science institute would lose for this reason, but there is certainly a large enough group of interested people remaining to exceed the 2,000 minimum necessary for such an establishment.

The remaining questions concerning an institute of plant sciences are: Are these groups really ready to proceed now? How shall they proceed? If they should start, are they prepared to follow through and bring their undertaking to a successful issue?

II. *Animal science group.* Aggregation of the animal sciences into a single organization would appear to offer far more of a problem than the accomplishment of such unification in the plant sciences. Some of the sources of disunity among the animal sciences seem to be the following:

(1) The entomologists, perhaps 2,000 strong, are closer to plant pathologists, agronomists, and horticulturists than they are to the Society of American Zoologists. They have rather uniformly chosen to hold their annual meetings in conjunction with the plant science groups.

(2) The field naturalists, another group of nearly 2,000, comprising the mammalogists, the herpetologists, the limnologists, the animal ecologists, and the wildlife specialists, differ widely by training, temperament, and outlook from the experimentalists.

(3) The group of about 3,000 which calls itself the Federation for Experimental Biology, *i.e.* American Physiological Society, American Society of Biological Chemists, American Society for Pharmacology and Experimental Therapeutics, American Society for Experimental Pathology, American Institute of Nutrition, American Association of Immunologists, has a strongly proclinical bent and finds its natural association largely, but by no means exclusively, with medicine. This very natural federation ought to be strengthened and developed beyond the stage of a forum for the presentation of research results, and of a common journal, into a strong national society similar to the engineering societies or to the American Medical Association.

(4) The groups concerned with farm animals, including the Dairy Science Association, the Society for Animal Production, and the Poultry Science Association, have more community of interest with agronomists than with zoologists. These three groups, together with the veterinarians and the U. S. Livestock Sanitary Association, have formed a loose federation of about 10,000 members to promote their common interests.

As to the original parent society of Section F, comparable to the Botanical Society of America in Section G, the Society of American Zoologists has not, in fact, maintained as broad and general a membership as has the Botanical Society, which for many years has successfully staged a "dinner for all botanists."

So far as an outsider can judge by duplicating memberships, etc., the largest fraction of the members of the American Society of Zoologists would probably be more interested in the Federation for Experimental Biology than in any of the other segments of animal science. A smaller number would be associated with the field naturalists, and the smallest fractions would find congenial surroundings among the sciences related to animal industry and entomology.

III. *Intermediate group.* After all the sciences dealing professedly with animal or plant material have been segregated, there remains a very important group of societies with approximately 7,000 members that frankly divides its interest as evenly as possible between animal and plant material. The members of this group, which includes geneticists, cytologists, biological chemists, ecologists, and the Society for the Study of Growth and Development, would be unhappy over the formation of separate institutes of plant and animal science but would welcome one institute binding all biologists together.

The 1,500 bacteriologists, although dealing unquestionably with plant material, would find less community of interest with the Botanical Society of America than with various medical groups or with societies associated with agriculture, such as the dairy scientists and plant pathologists. The microbiologists, among whom bacteriologists form the most numerous faction, are anxious to form a strong organization of their own but have not yet been able to produce a working institute. When they do so, they will greatly strengthen all biology.

It seems evident that separation of biologists into two groups, plant scientists and animal scientists, is not a satisfactory basis for segregating our groups and would not work well in practice.

I feel sure, therefore, that any unbiased study of the problem will lead to the conclusion that proper organization of the biological and agricultural sciences in this country demands the establishment of one over-all institute and half a dozen or more separate national groups concerned with the advancement of the biological sciences. Two of these groups are already organized and operating, namely, the American Veterinary Medical Association and the Society of American Foresters. Steps have been taken to strengthen the organization of entomology and to set up an institute in agronomy and related discipline. I hope these may bear fruit. We need others: one in plant science, pure and applied; one in entomology; one in proclinical experimental biology; one in microbiology; and one in animal production.

Such departmental organizations will, however, never be able to handle the public relations of biology as a whole, and at their best they could never have the necessary influence on public policies affecting biology.

NEED FOR AN OVER-ALL INSTITUTE TO DEAL WITH COMMON PROBLEMS

Although we in the biological sciences are apt to consider ourselves zoologists, botanists, physiologists, bacteriologists, or some other type of specialist, the public with whom we must deal considers biology as *one* science, and whether we like it or not, we must deal with the public on that basis.

At the time we were working to have a division of biology added to the proposed National Science Foundation, some biologists felt that the Foundation would be more effective if two divisions, one in plant science and another in animal science, were specified. I am sure, however, that those who have studied the long hearings on the bill will agree that it would have been impossible to have obtained the addition of two divisions in the biological field or to have secured recognition for any of the specialties to which we are devoted.

Our experience in allocating National Research Council Fellowships bears significant testimony to the impossibility of segmenting biology satisfactorily. Often, two applicants wish to work on essentially the same problem—one with plant material, the other with animal material. Should one arbitrarily be sent to a department of botany and the other to a department of zoology? In one type of problem, botanists may have made more progress, while in another, zoologists may be further advanced. It is therefore often advantageous to interchange men from one department to the other. A most interesting and important feature is that the proportion of applicants who cannot properly be segregated as botanists or as zoologists has increased markedly in recent years.

The relations of scientists to the public were changed by the war, and the orientation of science must be shifted to meet changed conditions. Briefly, the war brought home to the public, for the first time, the real importance of science. Science began in secret. It had to be kept out of sight of the bigoted leaders of the Middle Ages. The Royal Society of England, for a considerable period, was distinctly an underground organization that met in secret conclaves. With the granting of royal patronage, the classification of scientists in the public mind changed from "dangerous" to "harmless." Now the scientist is recognized for what, in truth, he is—indispensable to national security.

A national science policy is certainly going to be developed. The question before us is: Will the science of this Nation be guided by scientists who understand the needs of science or by laymen who do not? It is essential that scientists themselves organize and delegate some of their number, though it be only a small fraction, to look after the public relations of the scientific professions.

If it be granted that an over-all Institute of Biologists is needed, the practical question is: What shall we do now?

As the result of efforts of the group that sponsored the meeting in St. Louis, a committee widely representative of different kinds of biologists was recently called together to recommend further steps. The committee concluded that there ought to be an over-all institute for all biologists and requested the National Research Council to set up an institute within the Division of Biology and Agriculture. The Council will do anything it can to strengthen its service to biology and biologists. It would, however, be glad to be assured that the request of the committee has the backing of the national societies. The committee's resolution would be strengthened if each of the societies should similarly request the Council to set up such an institute.

The National Research Council is a cooperative association of scientists, as is the American Institute of Physics or the American Chemical Society, and, like them, it is managed and controlled by scientists. It has one great advantage over other scientific associations in that the importance of such an association was seen by the Government, and its formation was requested by an Executive Order of the President of the United States. A large majority of its members are elected by the scientific societies of the Nation. It has two further great advantages not possessed by any other scientific association:

(1) Covering all the fields of science, it can on occasion cross any of the boundaries that sometimes artifically separate scientific disciplines, and it can integrate all science.

(2) Because of its wide experience in administering grants from foundations and the confidence it has thereby inspired in donors of funds, it might be able to finance the new project more readily than could a group of independent biologists.

If it becomes clear that the biological societies and a substantial number of individual biologists will support the Institute, I believe I may say that the Council will attempt to underwrite it.

The most compelling reason for the immediate establishment of one over-all institute of American biologists remains yet to be given. The menace of atomic war is well advertised. It is so terrible that the physicists who know what it means have actively organized to forestall an atomic armament race; and they have gone far toward accomplishing their purpose.

It has been said, however, that if another war should come, it is more likely to be biological than atomic. There is no way to tell how much truth there may be in this statement. Let us hope there will be no war, but, war or no war, preparations for biological warfare are inescapably with us. It is clear that the very possibility of a biological war places an obligation on biologists to develop a considered collective consensus on the subject. That can be done solely by organized discussion such as is possible only through an institute.

A biological war could be far and away more terrible than an atomic war. Progress with the techniques of biological warfare has gone much further than most biologists realize. Although it has been stated that the "biggest research effort in the history of biology" was concerned with biological warfare—defensive as well as offensive—the public, and even the biological fraternity, has heard and thought little of the implication of biological warfare. Gerard Piel (*Life*, November 18, 1946) has stated: "There is as yet no body of responsible opinion on the subject of biological warfare. Formulation of such opinion cannot get under way too soon."

A more authoritative judgment to similar effect has been expressed by George W. Merck in an address at Pittsburgh. Mr. Merck was one of those entrusted, during the late conflict, with the guidance of this country's preparations for and against biological warfare. I quote:

> These investigations and the revelation of their inherent quality of producing not only weapons and defenses, but also fundamental advances of knowledge and practical contributions to medicine and agronomy, have necessitated *the writing of a new chapter in Biological Science.*
>
> * * *
>
> Those responsible for our defenses and preparedness in this upset world are alert; they have their programs ready. But they need support—support from scientists, academic and industrial, which should be given generously and in full measure—and it should not wait for an emergency call of patriotism.
>
> There must be support from the people through Congress and its proper committees. That means money for research. If anything is sure about such an investment, it is that it will pay large dividends—dividends for the nation's health and for the country's economy.

Shall biologists have any part to play in the formulation of public policy in biological warfare? We cannot do so as individuals. It must be a matter of group thinking and of group education. Biological warfare involves nearly every branch of plant and animal science: mycology, agronomy, animal husbandry, bacteriology, biochemistry, horticulture, entomology, ecology, mammalogy, veterinary medicine, physiology, both plant and animal. All biology must organize to lead the public in its thinking on biological matters.

Whatever our individual sciences may do to strengthen themselves in public service, it is clear that one over-all organization embracing all the biological sciences is essential *now.*

Research in Fundamental Biology and in Agriculture

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THE TIME IS RIPE FOR RE-EMPHASIS OF the fact that those in the fields of fundamental biology and agriculture derive many benefits from close association, and for calling attention to the opportunity they now have to work together in cooperation and mutual helpfulness to an unprecedented degree in the years immediately ahead. With the enactment by the Federal Government of the Hope-Flannagan measure, permitting appropriations of upwards of $9,500,000 for research in agriculture in 1947, with an increase each year to $61,000,000 in 1951, the way is open for development of a research program of a magnitude hardly yet fully understood or appreciated.

Speaking as one who has been concerned with problems of agriculture, specifically horticulture, I cannot pay enough tribute to the so-called fundamental field of biology for its contribution to the applied field. From the fundamental field comes the new approach, the revolutionary idea, the answer to many a practical problem. Much of the work of the applied field becomes involved in necessary service and in determining that one pound is as effective as two pounds. The basic or fundamental approach provides release from this routine. Added testimony to the contribution of the fundamental approach is the ever-increasing number of men in the applied field who seek training in basic subjects. In fact, in the field of horticulture the trend is to send students into the basic fields for a large part of their training, while maintaining seminars, reading rooms, and discussion groups to provide the horticultural point of view.

The close relation between biology and agriculture is implied in the definitions of the words themselves. Agriculture is "the cultivation of the soil for food products or any other useful or valuable growths of the field or garden," and biology is "the study of living matter." Just what "fundamental" means, as we use the word, is not so clear; I feel that we make altogether too much of it. As with moral codes, so with science: what is fundamental today is no longer so regarded tomorrow. If by fundamental we mean "essential" or "basic," then moisture is fundamental to tree growth, the tree is fundamental to the lumber industry, and lumber is fundamental to the carpenter. Only in the realm of an unsolved problem or an unprovided material does the word "essential" or "fundamental" seem to arise. Any new information is fundamental in the sense that sooner or later it is essential to something else. In fact, new and fundamental information is just as important to agriculture as are the products of agriculture to human welfare. We speak of the race between food supply and population, with famine as a possible outcome. We may as truly speak of the race between fundamental truths and the advance of agriculture, with famine both of applied truths and of foodstuffs as the possible result.

We also use the word to distinguish pure science from what we call the "applied" field. But in this usage, to say that this or that is fundamental often means merely: "I do not yet see the application." Often only a little imagination is required to transpose a "fundamental problem" into an "applied problem." So much of the so-called fundamental has application that many of us, I fear, literally pirate fundamental biology.

Of course, in all of this there is nothing new, but it needs restating, especially to administrators in the applied field who are responsible for the direction of programs and for the allocation of funds for research in agricultural problems.

So much for the importance of fundamental biology to agriculture. What of the importance of agriculture to fundamental biology? In general, I believe, the applied field is in turn helpful to the fundamental field.

Although there are those who are strong enough and able enough to stand alone and work out problems without regard to others, those individuals are rare. Whether they prosper because of their isolation or in spite of it is a case for argument. There is good reason to believe, however, that, either consciously or unconsciously, most of us work on problems because we see in them some relation to our fellow man, either in the form of attaining recognition of intellectual achievement and acquiring special skills, added power, and prestige or in the form of giving service and help to human beings. The desire to be of service to others is basic in the human race and something from which, as individuals, we derive perhaps our greatest satisfactions in life. The tying of fundamental study to some practical or useful outlet is natural and satisfying.

Not only does association with an applied field make the application of a fundamental truth possible, but it may also materially speed its adoption and thereby increase and hasten the satisfaction to the individual concerned. The rapidity in application of work with growth regulators in preventing preharvest drop of fruit, in killing weeds, and in inhibiting sprouting of potatoes is an outstanding example in which the fundamental, the applied, and industry have succeeded as a triumvirate in pushing ahead where each alone could not proceed. Surely the fundamental has been aided by being tied to the applied field in this particular instance. Would we have had hybrid corn sooner if it had been developed in an applied laboratory? To be sure, it may be said that applied laboratories were working in this field but failed to grasp its significance. However, is this not more a matter of the individual involved than of fundamental or applied science? Many fundamental or basic truth have come from applied laboratories, and there will be more as administration sees the value of a liberal interpretation of both basic and applied problems.

It must be admitted, nevertheless, that there is danger of suppression and of stifling research through improper direction, and I think it is this sort of thing that workers in the fundamental field fear. In this connection it may not be out of the way to quote the remarks of C. E. K. Mees, director of research for the Eastman Kodak Company:

> Research is a gamble. It cannot be conducted according to the rules of efficiency engineering. . . Research must be lavish of ideas, money and time. The best advice that I can give is don't quit easily, don't trust anybody's judgment but your own; especially don't take any advice from any commercial person or financial expert, and, finally, if you really don't know what to do match for it. . . . The best person to decide what research work shall be done is the man who is doing the research. The next best is the head of the department. After that you leave the field of best persons and meet increasingly worse groups. The first of these is the research director, who is probably wrong more than half the time. Then comes a committee, which is wrong most of the time. Finally there is the committee of company vice presidents, which is wrong all the time.

With most of that statement the majority of research workers will agree. Yet, to give the other side of the case, may not some of the difficulty lie with the research worker himself in not exercising sufficient imagination to tie his fundamental problem to the applied field? Cytogenetics may tie to breeding of a disease-resistant plant; photoperiod, to bolting of lettuce; tagged atoms, to controlling a virus trouble that threatens an industry; embryo culture, to producing a new rose or a cherry; and dormancy of seeds, to the nursery industry. To tie the fundamental to the applied is not a difficult task, but it is too often neglected. We forget that not many years ago a man labored half his life to become sufficiently independent financially to be able to carry on research. Nowadays the scientist is set aside by society to do this very thing. Is it too much to ask that we spend, say, 10 per cent of our time in harnessing our program to serviceable outlets? My experience is that not more than 10 per cent is required.

The applied field can bring financial support to research. Surely there is evidence that fundamental research has prospered when tied to the applied field. It seems to me that the loudest and most frequent pleas for financial assistance in the fundamental field are from those who have failed to tie to the applied field for support.

Closely related to financial support from the applied field is the encouragement that likewise springs from it. Man does not live by bread alone; neither does the research worker. Anyone who has experienced the enthusiastic support, encouragement, sympathy, and help that an applied field can provide will know what is meant. It is in many ways the most attractive feature of tying closely to the applied field.

Finally, the applied field offers specialists from different fields the opportunity to work together on the solution of a complex problem. We are in an age when the problems that can be solved by isolated individuals or groups are fewer and fewer. The era of cooperative attack is here. The applied field can provide both the specific problems around which specialists can rally to help each other and the means of support for an attack upon these problems.

It may be impertinent to ask whether a biologist really ever exists happily and successfully alone. It is probably not worth while to attempt to answer the question, but it may be worthy of passing comment. Like an active molecule, it is natural for a biologist to cleave to something. This does not destroy the usefulness or the value of a molecule; rather, it enhances its value. To be sure, there are molecules that exist uncombined with others, but it is the combined forms that are most helpful. Just so do biologists prosper when associated with or in symbiotic relation to medicine, plant and animal breeding, plant and animal pathology, agronomy, dairying, poultry husbandry, processing, canning, freezing, and scores of other fields.

Now we are approaching an era of public support for research such as that projected in the new Hope-Flannagan Act—support of gigantic proportions. Here is an opportunity and a challenge to both fundamental biology and agriculture. Agriculture needs the help of fundamental biology; without it, it will starve. Fundamental biology needs the support, the encouragement, the satisfying outlets, and the cooperative opportunities that agriculture can provide; without it, it may grow thin. Let us hope that a liberal attitude on the part of administrators in applied fields may prevail toward fundamental biology and that those in the fundamental field may find it attractive, worth while, and profitable to accept the encouragement, satisfaction, support, and opportunity for cooperative effort that the applied field can provide.

Possible Advantages of Cooperation Between Societies in Publication

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THERE SEEMS TO BE A RAPIDLY GROWING sentiment on the part of biologists toward some form of closer cooperation between the various societies—a sentiment based upon enlightened self-interest as well as upon a desire to contribute as fully as possible to the public welfare.

In the past, the tendency in biology has been toward disintegration. Those in the various fields of specialization have tended to work for the development of their own specialties to the neglect of the needs of biology as a whole. In so doing, they have failed to develop and support a more central and more general biological organization. One reason for this divisive tendency is the fact that biology is so diverse a field. The terminology and problems of one specialty are without meaning to many individuals in other specialties. There is not in biology, as there is in the fields of physics and chemistry, a large enough body of common knowledge and of common techniques to weld all biologists easily into a single, closely knit group. For this reason, biologists find it difficult to stick together; for this same reason, therefore, the need of cooperative effort and of organization is all the greater.

Although we biologists may speak many scientific languages, each being interested in matters unintelligible to many others, there is one thing that we all do in common. We all publish the results of our researches, and we all have to struggle with the problem of getting these results published promptly and economically.

That much can be done to increase the efficiency of our publications may be illustrated by reference to the situation I happen to know best—that of the *American Journal of Botany*. Financial reports of this journal from 1933 to date reveal some interesting facts. The average yearly income of the journal for the years 1936–44 was only slightly more than that for the years 1933–35, and the disbursements were only slightly less. We may say that these items have remained fairly constant. Nevertheless, with essentially the same income and expenses, the *American Journal of Botany* has, since 1936, achieved the following remarkable advances:

(1) It has increased its cash reserves 1,000 per cent.

(2) It has published, on the average, almost twice as much material per year since 1936 as in the years immediately preceding the reorganization (an average of 4,900,000 characters per annum vs. an average of 2,570,000).

(3) It has greatly decreased the time for publication of a paper, which averages at present between four and five months from date of receipt to date of publication, as

opposed to an average before 1936 of one and sometimes two years.

In short, with almost the same income and outgo, it has doubled its output, has reduced the time of publication to about one-fifth, and has increased its reserves by a factor of 10. This shows what can be accomplished when those who guide the destinies of a journal undertake to discover ways to increase its efficiency. Many other journals would, no doubt, benefit greatly by a similar study.

Dr. Griggs has kindly placed at my disposal a chart analyzing some 22 biological publications, plus a few general scientific or popular magazines, from the standpoint of efficiency of publication. A striking difference among the various journals in the list suggests that some journals may be printed more efficiently than others.

Let us consider, for example, the simple matter of the proportion of the page devoted to textual material. In *The Reader's Digest*, about 69 per cent of the page is occupied by printing; in *Time*, about 72 per cent. In one botanical publication, 67.1 per cent of the page is so occupied; in another, only 45.2 per cent. Then there is what Dr. Griggs calls the "index of economy"—the numbers of characters per unit area of page surface. The index for *Time* is 102; that for *The Reader's Digest*, 78.9. For one botanical journal it is 78.6; for another, it is only 43.8. One botanical journal thus has an "efficiency index" almost twice as high as that of another botanical journal. Obviously, much more remains to be accomplished in the direction of increased efficiency. These may be only minor items, since cost of paper is not of major importance in the total cost of publication. They suggest, however, the possibility that differences of greater importance exist among the various journals with respect to economy of publication.

It seems to me that development by various societies of a cooperative program of publication would be one of the best ways in which to bring about increased efficiency and to promote economy. I would suggest that such a joint program might involve two steps:

(1) A joint study might be undertaken of formats, typography, printing contracts, and other matters with a view to arriving at a plan that would result in maximum economy of publication with minimum fatigue to the reader.

(2) The societies might arrange to have their journals printed by the same firm, possibly under a joint contract. By standardization of printing specifications, the cost of printing could, no doubt, be greatly reduced. Consolidation of the business offices of these societies might result in further economies. Editorial policies would not be affected by such arrangements. Each society would continue, as at present, to control through its editorial board the rejection and selection of material.

I have seen correspondence between Dr. Griggs and a printer who, at the time of this correspondence, was publishing some 48 technical journals. It was the judgment of this printer that the joint publication of a group of journals with uniform format, typography, paper, and cover would save the participating journals up to 30 per cent in publishing costs. If the societies publishing these journals were also to give their accessory printing business to the same printer, the cost would be further reduced.

That this is not idle speculation is shown by the experience of the American Institute of Physics, which publishes 8 journals through a joint business office and a single printer. Some of these journals were losing large sums of money prior to the establishment of the Institute, but all are now in flourishing condition.

The possibility that biological journals could be published more economically by the cooperative effort of a number of societies should be thoroughly studied. It is only one of many advantages that might be derived from joint action, but it might prove to be one of the most tangible benefits to accrue from united effort.

What sort of cooperative organization might be set up to accomplish this and other benefits? Two proposals have been made for action on the part of botanists: (1) to establish an institute of botany; (2) to join in the organization of an American Institute of Biology. It is certain that botanical societies and botanists individually cannot support two such organizations. They will have to choose between them. If an institute of botanists were established, it would weaken an Institute of Biology if this were also set up. It might also result in the establishment of an "American Institute of Biology" that would include zoologists but not botanists—a situation that might prove to be very disadvantageous for the botanists.

It is my suggestion that the botanists do everything possible to aid in the studies which must precede the establishment of an American Institute of Biology; that they strive to bring out the sort of organization which will function most effectively in the furtherance of the work and welfare of both botany and zoology. If an Institute of Biology cannot be established on an effective basis, then will be the time to consider the formation of an American Institute of Botany.

Representatives from 27 national societies in the biological sciences, meeting together recently as an Organizing Board, have undertaken to solicit adherence to the American Institute of Biological Sciences from their respective societies as advocated, and the Institute is to be set up within the framework of the Division of Biology and Agriculture of the National Research Council, which is financing the preliminary Organization. H. B. Steinbach, Washington University, St. Louis, with headquarters at the NRC, is acting as executive Secretary during the period of organization.

NEWS *and Notes*

The Senate passed the National Science Foundation Bill on May 20, 1947. The bill passed was essentially S. 526 (*Science*, February 21, pp. 191–194) but with two major amendments. One provides that 25 per cent of the funds will be distributed to tax-supported and land-grant colleges; the other, that the Director of the Foundation will be appointed by the President of the United States instead of by the Executive Committee of the Foundation.

Other amendments added specific provision for research in cancer and other medical fields, broadened slightly the field from which nominations for membership in the Foundation will be secured, and altered slightly the wording of the tax provisions. These changes were adopted without opposition.

The Senate discussed the bill for four days. Most of this time was spent in debating amendments. Senator Kilgore introduced an amendment calling for the distribution of at least 25 per cent of the funds to the states and specifying that at least half of that money be spent in tax-supported and land-grant institutions; the other half would be available to private colleges and universities. This amendment was defeated. Senator Morse then introduced an amendment which also provided that at least 25 per cent be distributed to the states but which differed from the previous one in requiring that all this money be spent in tax-supported and land-grant institutions. It further provided that two-fifths of the 25 per cent be divided among the states in equal shares and the remainder in proportion to population. In order to secure any money under this provision, an institution must submit acceptable research proposals. Senator Morse's amendment, after considerable debate, passed by a vote of 42 to 40.

S. 526 originally authorized the President to appoint a National Science Foundation of 48 members. The Committee on Labor and Public Welfare reduced this number to 24. On the Senate floor an amendment which would have replaced the 24-member Foundation by a single Administrator was defeated. An amendment was then introduced by Senators Magnuson and Fulbright, giving the President power to appoint the Director as well as the Foundation. The Director would be appointed after consultation with the Foundation and would be subject to approval by the Senate. This amendment was frankly a compromise between two opposing points of view. One group believed that the Director should be appointed by, and be responsible to, the President; the other, that he should be selected by, and be responsible to, a large, independent board. The compromise expressed in the Magnuson-Fulbright amendment was proposed on May 1 by the Inter-Society Committee for a National Science Foundation and was supported by Senators Smith and Saltonstall as well as by its authors. It was strongly opposed by Senator Taft. This passed by a one-vote margin.

During the discussion of this amendment, two versions were considered. One gave both the President and the Foundation power to remove the Director. The other did not give that power to the Foundation. The version which was adopted gives removal power to the President, but not to the Foundation. Some of the Senators apparently were under the impression that they were voting for the other version. When the error was discovered, Senator Smith introduced a motion to reconsider, but later withdrew that motion. The press explained that he planned an attempt at giving the Foundation removal power when the House and Senate bills are brought together in conference.

An amendment creating a separate Division of Social Sciences, introduced by Senator Fulbright, failed to carry.

The final vote on the amended bill was 79 for to 8 against.

Scientists interested in the final adoption of science foundation legislation can now turn their attention to the House of Representatives. Its Committee on Interstate and Foreign Commerce held public hearings on science foundation bills on March 6 and 7. The next step necessary is for that Committee to submit a report recommending passage of the bill by the House of Representatives.

About People

Laurence H. Snyder, chairman of the Department of Zoology and Entomology, Ohio State University, delivered the Harry Burr Ferris Memorial Lecture at Yale University on April 30. His subject was "Principles of Gene Distribution in Human Populations."

William B. Davis, chairman, Department of Fish and Game, Texas A & M College, will head a group of 10 students in a cooperative study of an experimental deer range with the Colorado Fish and Game Commission near Meeker, Colorado, June 1–July 15.

Boris K. Likharev, paleontologist and member of the All-Union Geological Institute of the USSR, was honored at a special meeting of the Institute on March 20 upon the occasion of his 60th birthday and the 40th anniversary of his career in scientific research.

Llewelyn Williams, curator of economic botany, Chicago Natural History Museum, has returned to the Museum after a leave of absence of 15 months, devoted to the study of latex-yielding trees and to field trips in Mexico and the West Indies.

Knut Schmidt-Nielsen, research associate, Department of Zoology, Swarthmore College, has been appointed docent in biochemistry at the University of Oslo.

Van R. Potter, McArdle Memorial Cancer Research Laboratory, University of Wisconsin, recently presented a series of 10 lectures on the nature and activities of enzymes at the School of Medicine, University of Louisville, Kentucky.

O. E. Jennings and **E. R. Eller** were awarded the honorary degrees of LL.D.

and D.Sc., respectively, at the convocation of Waynesburg College, Pennsylvania, on February 24. Dr. Jennings is director, and Mr. Eller, curator of Invertebrate Paleontology, at Carnegie Museum, Pittsburgh.

Phillips M. Brooks, formerly with the Army Air Corps, where he conducted research in temperature tolerances and physiological hazards of high-altitude flight, has been appointed plant physiologist for the Natural Rubber Research Project at Salinas, which is conducted by the Stanford Research Institute under contract with the Office of Naval Research.

Visitors to U. S.

Plinio Rodriguez, of the Butantan Institute, São Paulo, Brazil, spent two weeks during April at the University of Texas Medical Branch, Galveston, to learn new methods of studying rickettsial diseases developed by Ludwik Anigstein. Dr. Rodriguez is visiting U. S. medical research centers under the auspices of the Coordinator of Inter-American Affairs, Washington, D. C.

Paul A. M. Dirac, Lucasian professor of mathematics, University of Cambridge, has been appointed visiting professor in the School of Mathematics, Institute for Advanced Study, Princeton, for the academic year beginning September 1947.

Grants and Awards

The American Society of Agronomy has established two new $500 annual awards for outstanding agronomy research from funds provided by W. H. Stevenson, vice-director of the Iowa Agricultural Experiment Station, and Mrs. Stevenson. Dr. Stevenson was head of the Department of Agronomy, Iowa State College, from 1910 to 1932, and has been vice-director of the Station for 35 years. He is also known for work as director of the Iowa Soil Survey.

The Massachusetts General Hospital Warren Triennial Prize for 1946 has been awarded to Paul C. Zamecnik and Fritz Lipmann for their essay, "Studies on *Cl. welchii* lecithinase," according to Joseph C. Aub, director, Cancer Commission of Harvard University, Massachusetts General Hospital, Boston.

Reuben Roseman, formerly of the 32nd General Hospital, U. S. Army, and at present with the Glidden Company, Baltimore, Maryland, has received the Bronze Medal of the University of Liége, Belgium, for aid rendered to the Bavière Hospital of the University during the war.

Scholarships

The John N. Derschug Memorial Scholarship in Engineering is to be founded at the College of Applied Science, Syracuse University, this fall. The annual scholarships will cover full tuition and expenses for complete courses in engineering given during the academic year. The fund for the scholarships has been provided by the Easy Washing Machine Corporation in honor of its founder, John N. Derschug.

Further details may be obtained from Dean Louis Mitchell, College of Applied Science, Syracuse University, Syracuse, New York.

Oklahoma Baptist University announces that 1947–48 graduate assistantships are available in the Departments of Geology, Biology, Chemistry, Home Economics, and Mathematics. Those interested may apply to John W. Raley, President, Oklahoma Baptist University, Shawnee, Oklahoma.

Colleges and Universities

A new photoelectric instrument, called a particle counter, has been developed in the Chemistry Department of Northwestern University. Announcement of the device was made by Frank T. Gucker, Jr., professor of chemistry, at the recent meeting of the American Chemical Society in Atlantic City, New Jersey. Collaborating with Prof. Gucker in developing the counter were: Chester T. O'Konski, research associate at Northwestern; Hugh B. Pickard, now assistant professor of chemistry, University of Maryland; and James N. Pitts, Jr., a candidate for the Ph.D. degree in chemistry at the University of California, Los Angeles.

The instrument, which automatically counts bacteria or smoke particles with diameters as small as 25 millionths of an inch and four millionths of a billionth of an ounce in weight, will be useful to the research bacteriologist in testing contamination and to industrial plants producing pharmaceuticals or chemicals by fermentation. According to Prof. Gucker, "the counter also may serve in detecting dust which must be excluded in the manufacture of photographic film and fine optical instruments."

The apparatus was designed and built originally under a contract with OSRD and improved under a subsequent contract with the Army Service Forces to test the filters of gas masks.

Summer Programs

The Ohio State University College of Agriculture will offer four new courses in fruit and vegetable technology beginning with the summer quarter on June 17. These courses have been designed to give students an opportunity to learn the beginning-to-end processing involved in the preservation, manufacture, quality control practices, and procedures used in fruit and vegetable canning, freezing, and dehydrating. Laboratory work will include inspection trips to food plants and the grading of preserved foods according to government standards.

Frederick C. Leonard, professor of astronomy, University of California, Los Angeles, will give a combined course in astronomy and meteoritics and a course in mathematics in the summer session of the University of New Mexico, Albuquerque, June 9–August 6. Dr. Leonard is a research associate of the Institute of Meteoritics, University of New Mexico

Industrial Laboratories

Bausch & Lomb Optical Company has elected Ivan L. Nixon, manager of the Instrument Division, and Ben A. Ramaker, manager of the Ophthalmic Division, as vice-presidents. Re-elected were M. Herbert Eisenhart, president; Joseph F. Taylor, vice-president and treasurer; Carl L. Bausch, Theodore B. Drescher, and Carl S. Hallauer, vice-presidents; and Edmond S. LaRose, controller.

The Zemmer Company, Inc., Pittsburgh, Pennsylvania, has announced the appointment of Kenneth L. Waters as technical director. Formerly a pharmaceutical research specialist in Mellon Institute, Dr. Waters has been engaged in the revisional work of the new *U. S. Pharmacopoeia*

Eastman Kodak Company has completed a giant aerial telephoto lens, built for the Army Air Forces. Designed for experimental aerial photography, the lens, measuring about a foot in diameter and four feet long and weighing about 125 pounds, has a 48-inch focal length, an f/6.3 aperture, and a built-in heating system to conteract the effects of subzero temperatures at high altitudes. The new lens will permit large, sharp photographs to be taken from as much as a 10-mile altitude.

Eli Lilly and Company has appointed T. P. Carney head of the General Organic Chemical Research Department of the Lilly Research Laboratories. He was formerly with Reilly Tar and Chemical Company.

Elections

George B. Barbour, dean of the University of Cincinnati College of Liberal Arts, has been elected a corresponding member of the Royal Geographic Society of Belgium in recognition of his distinguished work in the field of geomorphology.

Harold Clayton Urey, director of the Institute of Nuclear Studies, University of Chicago, has been elected a foreign member of the Royal Society of London.

R. B. H. Gradwohl, director, Gradwohl Laboratories and Gradwohl School of Laboratory Technique, St. Louis, Missouri, was elected a Fellow of the Royal Society of Tropical Medicine and Hygiene, London, December 12.

E. E. Ecker, professor of immunology, Western Reserve University, has been elected Councillor of Honor, National Council on Scientific Investigations of Spain. Dr. Ecker, who recently returned from a tour of Europe, where he delivered a series of lectures on medical subjects, is also a member of the Royal Academy of Medicine of Spain.

Robert Cushman Murphy, American Museum of Natural History, New York, has been elected an honorary member of the California Academy of Sciences.

NRC News

Fellowships for research training in a number of scientific fields, including the applied sciences, are administered by the NRC. The support of these fellowships is derived from foundations, national societies, and industrial organizations.

The Merck Fellowship Board of the Council has awarded five fellowships for the year 1947–48, the first to be granted under a program established last November by a gift of $100,000 from Merck & Co., Inc. The purpose of these awards is to provide advanced training in the related fields of chemistry and biology and thus foster the development of scientific leaders with broad competence. In accepting this gift the chairman of the NRC pointed out that these fellowships will set a pattern for the more effective participation of American industry in the training of scientific personnel.

The high caliber of the 49 applicants for the awards is evidence of the wisdom and need of the Merck gift. From among the candidates the following were selected:

Joseph Lein, New York City, for a study of the specificity of enzymes produced by mutated and nonmutated genes in *Neurospora* at California Institute of Technology.

Lorin John Mullins, Palo Alto, California, to work at the Naples Zoological Station, Naples, Italy, on the experimental modification of permeability phenomena in marine vertebrates and invertebrates.

Arthur Beck Pardee, Pasadena, California, for work at the University of Wisconsin. He will conduct researches in general physiology, histology, cytology, and related fields, as preparation for a career in medical research.

B. Roger Ray, Nampa, Idaho, for work at the Rockefeller Institute for Medical Research on the determination of movements of salts through certain nonaqueous solutions by means of high-speed centrifugation, the results of which will apply to the problem of cell permeability.

Nevin Stewart Scrimshaw, Rochester, New York, for a biochemical study of factors associated with toxic complications of pregnancy and fetal abnormalities at the University of Rochester.

The Board which made these selections consisted of: A. N. Richards, University of Pennsylvania, chairman; George W. Beadle, California Institute of Technology; Hans T. Clarke, Columbia University; George O. Curme, Jr., Carbide and Carbon Chemicals Corporation; Rene J. Dubos, Rockefeller Institute for Medical Research; and Detlev W. Bronk, chairman of the NRC (*ex officio*).

Fellowships to promote fundamental research in the Natural Sciences are supported by a grant from the Rockefeller Foundation. These are awarded to young men and women who have demonstrated outstanding ability in research for the purpose of enabling them to gain further experience in conducting investigations at institutions which make adequate provision for effective prosecution of such work. Recipients of the 12 awards made for 1947–48 are:

Robert O. Bloomer, New York, to study the structure and stratigraphy of the Blue Ridge in Virginia, at Harvard University.

Gene B. Carpenter, Cambridge, Massachusetts, to work on an X-ray diffraction investigation of the solid forms of cyclohexane at California Institute of Technology.

John K. Galt, Portland, Oregon, to work on relaxation processes in ferromagnetic materials at the H. H. Wills Physical Laboratory, Bristol, England.

Bernard Hammermesh, a reappointment, to continue work at California Institute of Technology. His research will be on the mesotron energy spectrum.

Tong Hing, New York City, to conduct researches on normed rings and topological spaces at the Institute for Advanced Study.

John P. Hummel, Northfield, Minnesota, to conduct researches on a study of oxidative phosphorylation disturbances on myopathies at Wenner-Grens Institute, Stockholm, Sweden.

Edward S. Lewis, Weymouth, Massachusetts, to work at the University of California, Los Angeles, on the mechanism of the Sandmeyer reaction.

F. Harlan Lewis, Redlands, California, to conduct researches on a cytological study of the genus *Godetia* at the John Innes Horticultural Institute, London, England.

Herman Rubin, Chicago, Illinois, to conduct researches on systems of temporal stochastic equations at the Institute for Advanced Study.

Merle E. Tuberg, Rochester, Minnesota, a reappointment, to conduct researches on atomic structure calculations at Girton College, Cambridge, England.

Eugene C. Worman, Jr., Cambridge, Massachusetts, to conduct researches on the prehistoric and early historic cultures of India and their relations to others in the Near East and Far East, at Harvard University.

Daniel Zelinsky, Chicago, Illinois, to work on topological algebra of nonassociative systems at the Institute for Advanced Study.

The Board of Selection consisted of: Detlev W. Bronk, chairman, NRC;

Rollin T. Chamberlin, University of Chicago; M. H. Jacobs, University of Pennsylvania; Frank B. Jewett, National Academy of Sciences; Duncan A. MacInnes, Rockefeller Institute; and John C. Slater, Massachusetts Institute of Technology.

The Medical Fellowship Board is enabled, by a grant from the Rockefeller Foundation, to offer the National Research Fellowships in the Medical Sciences, designed to give special facilities for training and experience in research to persons who wish to devote themselves to an investigative career in the medical sciences. Such awards are intended for recent graduates who are not yet professionally established.

The Rockefeller Foundation has also provided the Council with funds in support of the Welch Fellowships in Internal Medicine. These are of senior grade and are intended to provide a prolonged period of advanced training for individuals of proven ability in research.

The National Foundation for Infantile Paralysis, Inc., has made available a grant in support of research fellowships in fields related to infantile paralysis. Under this appropriation, fellowships are offered (1) to provide opportunities for training and research in those basic medical sciences which will be of particular value in furthering progress in the field of orthopedic surgery and (2) for special experience in the study of virus diseases. Senior Fellowships in the fields of orthopedic surgery, pediatrics, and virus diseases, open to men and women who have already shown definite achievement in research, are also offered under this grant.

Fellowships in Anesthesiology, designed to give the candidate a year or more of experience in the sciences basic to anesthesiology, have been provided by a grant from the American Society of Anesthesiologists, Inc.

Twenty-eight new fellows received appointments for 1947–48, and 10 fellowships were renewed at meetings in March and April 1947. In addition, 7 fellows were granted three-year appointments to Welch or Senior Fellowships during 1946 and will therefore serve the second year of their terms during 1947–48. The 45 fellows holding appointments for the year 1947–48 are listed below:

Fellows in the Medical Sciences:

Forrest H. Adams, San Diego, California, to work in the field of pediatrics at the University of Minnesota.

Jerry K. Aikawa, Alameda, California, to study the pathological physiology of rheumatic fever at the University of California Medical School.

Rose G. Ames, Jackson Heights, New York, to study renal function in infancy at the Babies Hospital, New York City.

John M. Buchanan, Kalamazoo, Michigan, for work at the Nobel Institute, Stockholm, Sweden, on the isolation and purification of an iron-proteid substance found in milk (renewal).

Donald G. C. Clark, New Haven, Connecticut, to study the proteolysin inhibitor in mammalian blood at the Yale University School of Medicine.

Harry F. Colfer, Dillon, Montana, for correlative studies of the electrophysiology and the electrolyte equilibria of nerve cells at Cambridge University, Cambridge, England.

Robert H. Furman, Schenectady, New York, to study the physiology of coronary occlusion at Vanderbilt University School of Medicine.

Robert J. Glaser, St. Louis, Missouri, to study the pathogenesis of the rheumatic diseases at Washington University School of Medicine, St. Louis.

Willard E. Goodwin, Montrose, California, to study prostatic and renal physiology at the Johns Hopkins Hospital, Baltimore, Maryland.

David G. Greene, Buffalo, New York, to study the pathological physiology of chronic pulmonary disease and of congenital heart disease at the College of Physicians and Surgeons, Columbia University.

Daniel L. Kline, New York City, for an *in vitro* study of hormonal influences in protein metabolism at Yale University School of Medicine.

Robert S. Knighton, Los Angeles, California, to study frontothalamic connections at the Montreal Neurological Institute.

Benjamin A. Levitan, Ottawa, Canada, to study the trophic effect of cholinergic drugs at McGill University, Montreal.

Herman C. Lichstein, Madison, Wisconsin, to study the amino acid metabolism of bacteria at Cornell University (renewal).

William F. Loomis, Tuxedo Park, New York, to study the enzymatic oxidations of the tricarboxylic acid cycle at Massachusetts General Hospital, Boston (renewal).

Gilbert H. Mudge, New York City, to study the lymphocidal and cytotoxic action of nitrogen mustard with comparison to radiotherapy at the College of Physicians and Surgeons, Columbia University.

Sanford L. Palay, Cleveland, Ohio, to study the localization of functions in the cell at the Rockefeller Institute for Medical Research, New York City.

Gifford B. Pinchot, Milford, Pennsylvania, to study the metabolic changes produced in the host by *B. tularense* infection at the Yale University School of Medicine (renewal).

Ernest Sachs, Jr., St. Louis, Missouri, to study autonomic representation in the cerebral cortex at Yale University School of Medicine.

Alvin L. Sellers, Los Angeles, California, to study the nature of vascular hypertension at the University of London Medical School, London, England.

Joseph R. Stern, Toronto, Canada, to study the intermediary metabolism of carbohydrate and of protein at the University of Sheffield, England.

Welch Fellows in Internal Medicine:

S. Howard Armstrong, Jr., Boston, Massachusetts, to study the interaction of proteins and small molecules of known biological and chemical specificity at the Massachusetts Institute of Technology (renewal).

James H. Baxter, Jr., Ashburn, Georgia, to study liver and kidney injury produced in rats by diets containing pyridine; location of work to be determined (second year).

John V. Taggart, New York City, to study the nature of enzyme systems in various disease states at the College of Physicians and Surgeons, Columbia University (second year).

Fellow in Orthopedic Surgery:

Thomas Gucker, III, Philadelphia, Pennsylvania, to study the circulation in normal and paralytic extremities at the Children's Hospital, Boston (renewal).

Fellows in the Field of Virus Diseases:

Harvey Blank, Chicago, Illinois, to study infection with the virus of herpes simplex at the University of Pennsylvania and at the Children's Hospital, Philadelphia.

Bernard A. Briody, Jr., Bethlehem, Pennsylvania, to study the interference phenomenon in filtrable viruses at the University of Michigan (renewal).

Fred M. Davenport, Greenwich, Connecticut, to study the etiology and pathogenesis of acute infections of the respiratory tract at the Rockefeller Institute for Medical Research, New York City.

J. Lester McCallum, Avoca, Quebec, Canada, to study immunity in virus diseases at the University of Michigan.

Robert Rustigian, Medford, Massachusetts, to study the diagnosis of virus diseases at Harvard Medical School, Boston (renewal).

Duard L. Walker, San Francisco, California, to study the transmission of pneumotropic viruses at the Rockefeller Institute for Medical Research, New York City.

Senior Fellows in Pediatrics:

Gordon E. Gibbs, San Francisco, California, to study pancreatic disease in childhood at the University of California Hospital, San Francisco.

Victor A. Najjar, Baltimore, Maryland, for work on the purification of the enzyme phosphoglucomutase and study of its kinetics at the Washington University School of Medicine, St. Louis (renewal).

John L. Peck, Baltimore, Maryland, to study tissue antigens and antibodies in the pathogenesis of disease at the Johns Hopkins Hospital, Baltimore.

Edward L. Pratt, Boston, Massachusetts, to study water and electrolyte metabolism at Yale University School of Medicine (second year).

Alex J. Steigman, Philadelphia, Pennsylvania, to study the adaptation of human poliomyelitis viruses in mice of varying genetic constitution at the Children's Hospital Research Foundation, Cincinnati, Ohio.

James E. Ziegler, Jr., San Francisco, California, to study the chemistry of cellular enzymes at Yale University (second year).

Senior Fellows in the Field of Virus Diseases:

Martha B. Baylor, Chicago, Illinois, to study the genetics of tobacco mosaic virus at the Rockefeller Institute for Medical Research.

Lewis L. Coriell, Missoula, Montana, to study herpes simplex at the Children's Hospital of Philadelphia.

Harry A. Feldman, Washington, D. C., for work on the isolation of the measles virus and the development of the immune mechanisms and epidemiology of the disease at the Children's Hospital Research Foundation, Cincinnati, Ohio (second year).

Herbert R. Morgan, Riverside, California, to study methods for the isolation of viruses from contaminated materials at Thorndike Memorial Laboratory, Boston (second year).

John R. Neefe, Philadelphia, Pennsylvania, to study infectious hepatitis at the University of Pennsylvania (second year).

Frederick C. Robbins, Bronxville, New York, to study the epidemiology and possible viral etiology of infantile diarrheas and means of increasing the quantity of the viruses of the poliomyelitis group at the Children's Hospital, Boston.

Fellows in Anesthesiology:

Simpson S. Burke, Jr., Los Angeles, California, to study carbon dioxide absorption and analysis of nitrous oxide mixtures at the University of Wisconsin (renewal).

Margaret C. Pratt, Detroit, Michigan, to study the influence of pontine reticular nuclei on reflex response to anoxia and to make a comparative study of procedures for maintenance of oxygenation in pneumonectomy and occlusion of pulmonary vessels at McGill University, Montreal.

All of the fellowships listed above are administered by the Medical Fellowship Board, which is composed of: Robert F. Loeb, Columbia University, chairman; G. W. Beadle, California Institute of Technology; Alfred Blalock, Johns Hopkins University; Paul R. Cannon, University of Chicago; W. U. Gardner, Yale University; A. Baird Hastings, Harvard Medical School; T. Grier Miller, University of Pennsylvania; Homer W. Smith, New York University; A. Ashley Weech, University of Cincinnati; and John B. Youmans, University of Illinois.

A Norwegian-Swedish-British expedition to Antarctica is being planned for the autumn and winter of 1948, according to the American-Swedish News Exchange, Inc. Technical preparations for the expedition are in charge of Gen. Hjalmar Riiser-Larsen, an adviser with the Scandinavian Airlines System in Stockholm and former head of the Norwegian Air Corps, who will also lead the expedition if his advisory duties to the Airline permit. The scientific planning of the expedition is being handled by Hans W. Ahlmann, professor of geography, Stockholm University, who has led many Arctic expeditions and is known for his glaciological research. The landing party, as now planned, will include a geographer, biologist, meteorologist, and glaciologist from each country.

A 5,000-ton former German troopship, the "Svalbard," now belonging to Norway, will carry the party to Crown Princess Astrid Land, which will be the base of operation.

The American Institute for Research, Pittsburgh, incorporated last year as a nonprofit organization to carry out a research program in personnel psychology, is currently working on the problem of increased safety in commercial airline flying at the request of the Civil Aeronautics Administration. The project is being carried on under a contract with the Committee on Selection and Training of Aircraft Pilots, National Research Council. A critical analysis of the pilot's job is the immediate goal of the project. All relevant aspects of airline flying are being studied, and both the pilots' organization and the airline companies are cooperating with the Institute to insure representative results.

Other projects on which work is now in progress include the development of improved procedures for evaluating the efficiency of Army Air Force officers and the development of new types of aptitude and personality tests.

Although the main offices of the Institute are located in the Cathedral of Learning, University of Pittsburgh, there is no official connection with the University. Several members of the organization, however, hold appointments in the Department of Psychology.

Make Plans for—

The American Heart Association, Inc., annual meeting, June 6–8, Atlantic City, New Jersey.

American Society for the Study of Blood, organizational meeting, June 8, Hotel Claridge, Atlantic City. New Jersey.

American Institute of Electrical Engineers, summer general meeting, June 9–13, Montreal.

American Medical Association, centennial session, June 9–13, Atlantic City, New Jersey.

American Society of Mechanical Engineers, wood industries national conference, June 12–13, Madison, Wisconsin.

COMMENTS *by Readers*

A note in this journal (*Science*, 1946, **104,** 426) cautions against use of sulfuric acid-dichromate mixtures in cleaning glassware for microbiological experiments because of the possible toxic action of the traces of dichromate that often remain on or in the glass, even after repeated rinses. Figures showing retarded growth of various microorganisms and inhibition of enzyme systems in the presence of extremely low concentrations of dichromate are cited. In view of this note and the relatively high degree of toxicity generally attributed to chromium and dichromates, the following observation is of special interest, since it shows that under certain conditions traces of dichromate might also distort experimental results, not by exerting an inhibitory action but by causing stimulation.

During the course of a study of biosynthesis of penicillin by *Penicillium chrysogenum* X-1612 in shake flasks, we attempted to formulate the simplest synthetic medium, composed exclusively of compounds readily available in industrial quantities, that is capable of yielding reasonable concentrations of penicillin. It was found that chromium, furnished as $K_2Cr_2O_7$, was beneficial in this solution (*Science*, 1945, **102,** 482). We were interested to observe the necessity of adding Cr, and probably Al, for biosynthesis of penicillin in the basal synthetic medium where penicillin had to be synthesized from minerals, and from carbon supplied in the form of lactose, starch, glucose, and acetic acid.

Later experiments showed that when the concentration of Cr (supplied as $K_2Cr_2O_7$) was raised from 1 γ/l. to 20 γ/l., the maximum titer of penicillin in the crude liquor was increased from 50 Oxford units/ml. to about 85. Solutions containing 7.5 and 10 γ Cr/l. produced titers of about 70 and 75 units/ml., respectively. Solutions containing 100 γ Cr/l. yielded 85 units/ml., and those with as much as 200 γ Cr/l. permitted good growth of the mold and produced about 55 units of penicillin/ml. In these experiments the concentration of Al (furnished as Al acetate) was 3.6 γ/l. Virtually no penicillin was produced in the basal medium prepared with distilled water when no $K_2Cr_2O_7$ was added. The penicillin potencies were determined by the standard cylinder-plate method using *Staphylococcus aureus* NRRL 313 as the test organism and a standard of calcium penicillin G.

Strictly speaking, Cr and Al should not be designated "essential," since it has not been determined that no other elements can substitute satisfactorily for them. However, in our experiments penicillin could not be detected in the solution in their absence, and no other elements tested (Mo, Ce, Co, Ni) replaced them satisfactorily. This suggests that perhaps Cr and Al may be effective in catalyzing cyclizations and condensations involved in the biosynthesis of penicillin as they are in chemical synthesis (*Ind. eng. Chem.* (Ind. ed.), 1945, **37,** 356, 1038). The biocatalytic activity of Cr may be exerted through a stimulating effect on enzyme systems such as has been reported previously (*J. biol. Chem.*, 1939, **128,** 251). (ROBERTSON PRATT and JEAN DUFRENOY, *University of California College of Pharmacy, San Francisco.*)

Devotion of a rather large amount of space (*Science*, 1946, **104,** 373–374) to the description of what today may be fairly termed a relatively crude device suggests quite strongly that enough of our scientific colleagues bedeviled by the problems of circuit control are not fully oriented with modern resources.

Before the advent of modern relays I made many enforced practical studies on their lack of function, especially troublesome with heater circuits where thermostatic failure adds its contribution. Certain practical points garnered from years of experience may therefore be worthy of record for the benefit of those less interested in such matters. The key to accurate thermostatic control is a sensitive thermostat. This is almost inevitably associated with an inability to handle heavy currents, or sparking occurs at the contacts, leading to eventual failure. The natural corollary is that the associated relay must operate from small currents. In practice this should be less than 10 Ma. As a-c relays are now available, it is generally better to use them, since the sparking at contacts is less than an equivalent d-c load and consequently corrosion and sticking are minimized. Of the many and varied attempts to eliminate sparking at contacts, none has been entirely successful from a practical standpoint, in which expense is one real factor. Unless care is taken to match the circuit load correctly with the appropriate size of condenser, the use of these alone to suppress sparking may be quite unsatisfactory. In actual practice the condenser large enough to suppress nearly all visible sparking is too large, for its own charge, when released by contact closure, may be, and indeed often is, heavy enough to fuse the points and cause troublesome sticking.

For heavy loads such as heater circuits, I have found the use of a simple high-resistance bridge to be as effective and easier than the use of condensers. This is a small lamp that also has signal value. Where condensers are used, it is still advisable to use such a bridge so that they may be slowly discharged. This saves a good deal of contact "make" sticking. For a-c circuits a choke coil could be used. As the modern "wipe" silver contacts work well with heavy loads—5–10 amp. or more—the advantages of the more expensive, clumsy but sealed in, mercury contacts, except in very dusty or humid environments (stoker furnace controls) is now less apparent. Moreover, they will operate only at slow speeds, due to the internal sloshing of the mercury that may eventually set up a continuous arc. Their use inevitably leads to a bulkier apparatus. The mercury contacts are being replaced for many purposes by the remarkable little 4-ounce pressure switch, a highly sensitive switch operating off a slight pressure and short throw. These are admirably incorporated into relay controls and are also sealed in. They may be found operating the cheap but serviceable "brooder" thermostatic controls, as well as the more expensive room thermostats. The standard ones available cost a few cents and will handle some 5 amp. at 115 volts (a-c).

For all ordinary purposes a visit to the local radio store will uncover a variety of relays (both a-c and d-c types), of quite remarkable sensitivity and endurance, costing in the order of $5.00 or less. A slightly more expensive instrument and one that I have found by experience to be an almost ideal laboratory tool, is the type 29XAX in the collection of fine relays made by Struthers-Dunn, of Philadelphia. This compact device operates on 5 Ma. at 115 a-c and is rated to carry 2 amp. at that same voltage. It actually carries heavier loads quite comfortably, providing circuit interruption is not too frequent. This type of relay has the advantage of working directly off the house current. If for some reason the high voltage is objectionable at the control point, a similar relay, wound for a lower voltage used with a step-down transformer, can be used. Both relays and transformers are now readily available and obviate very largely the use of batteries. (O. S. Gibbs, *1544–46 Netherwood, Memphis, Tennessee.)*

Reflection on the mechanism of action of chemotherapeutic drugs has led to the concept of specific bacterial enzyme inhibition. The exact mechanism of the inhibition is not yet known [see reviews by Henry (*Bact. Rev.*, 1943, **7**, 175), Frieden (*Texas Rep. Biol. Med.*, 1945, **3**, 569), and Mudd (*J. Bact.*, 1945, **49**, 527)].

Obligate intracellular organisms are dependent on some of the enzyme systems of the host cells, and their growth is affected and can be influenced by varying enzyme metabolism of the host cells. It has been shown by Greiff, Pinkerton, and Moragues (*J. exp. Med.*, 1944, **80**, 561) that rickettsial growth is depressed by the host cell enzyme activator, p-aminobenzoic acid (PABA). Presumably, the metabolic stimulation of the host cells by PABA makes it an unfavorable environment for rickettsial proliferation, which proceeds at an accelerated rate under conditions of lowered cellular metabolism as produced by sulfonamides, sodium fluoride, or deficiency of riboflavin.

For the control of rickettsial infections it is desirable to increase cell metabolism, inasmuch as rickettsial growth is increased in slowly metabolizing cells whether produced by vitamin, protein, or oxygen deficiencies or following radiation trauma. PABA has been found effective in endemic and epidemic typhus, Rocky Mountain spotted fever, and scrub typhus [see review by Anigstein and Bader (*Texas Rep. Biol. Med.*, 1946, **4**, 260)].

Sprunt (*J. exp. Med.*, 1942, **75**, 297) confirmed Rivers' clinical impression that vaccinia virus "is less able to multiply in the poorly nourished cells than in the well nourished one."

Foster, Jones, Henle, and Dorfman (*Proc. Soc. exp. Biol. Med.*, 1942, **51**, 215; *Science*, 1943, **97**, 207; *J. exp. Med.*, 1944, **79**, 221; 1944, **80**, 257) demonstrated that deaths from poliomyelitis virus (Lansing strain) and especially paralysis decreased in mice subjected to thiamine deficiency, restricted food intake, or both. Rassmussen, Waisman, Elvehjem, and Clark (*J. inf. Dis.*, 1944, **74**, 41) reported similar findings for the Lansing strain of poliomyelitis virus as well as for Theiler's virus. Presumably, the host cell metabolism (cocarboxylase) is so inhibited as to be insufficient to support poliomyelitis virus growth, although it seems to be sufficient for cell survival in most instances.

It seems to date that the therapeutic implications of these observations have not been sufficiently emphasized and investigated, although Mudd (*J. Bact.*, 1945, **49**, 527, footnote 2) implies the use suggested below. An attempt might be made to produce a vitamin (coenzyme) deficiency in the early stages of the disease which will make host cells an unsuitable environment for further virus proliferation. Possibly this is analogous to the action of sulfonamides in certain infections with the ornithosis and lymphogranuloma group of viruses (although a direct effect on the virus is difficult to exclude, since virus does not multiply demonstrably apart from living cells).

A thiamine deficiency may be produced by feeding such homologues as pyrithiamine, 2-n-butyl thiamine, or o-aminobenzyl-methyl thiazolium chloride. Possibly this deficiency in susceptible cells might be brought about rapidly, severely, and safely enough in the early stages of infection, thereby depressing further multiplication of poliomyelitis and possibly other neurotropic viruses (increasing "natural resistance") until the acquired immunity mechanisms are brought into operation.

Other intracellular infections might respond to vitamin-deficiency-producing drugs. It has been shown by Seeler and Ott (*J. inf. Dis.*, 1944, **75**, 175) that riboflavin deficiency in chickens produces lighter infections with *Plasmodium lophurae* malaria than in normal controls. In this case galactoflavin or isoriboflavin may be efficient in producing such riboflavin (flavoprotein dehydrogenase enzyme) deficiency. Mudd has also pointed to the structural similarity of riboflavin and atabrine, the antimalarial drug.

Some of the other vitamin antagonists (homologues, vitagonists) are pyridine-3-sulfonic acid and β-acetylpyridine for nicotinic acid; 4-desoxypyridoxine for pyridoxine; desthiobiotin, biotin-sulfone, and imidazolidone caproic acid for biotin; phenylpantothenone and pantoyltaurine for pantothenic acid; dicumarol, iodinine, and salicylic acid for vitamin K (see Woolley, *Science*, 1944, **100**, 579; *Adv. Enzymol.*, 1946, **6**, 129; Roblin, *Chem. Rev.*, 1946, **38**, 255).

Species differences with respect to the response to vitamin deficiencies have been observed. Rats could be protected against a hemolytic streptococcus by pantoyltaurine, whereas mice, whose blood pentothenate level is 5–10 times higher, could not be so protected (McIlwain and Hawkins, *Lancet*, 1943, **1**, 449). Thiamine deficiency did not significantly effect poliomyelitis infection (Lansing strain) in cotton rats (Weaver, *Amer. J. Dis. Child.*, 1946, **72**, 6), whereas mice were markedly protected by such deficiency. This is perhaps significant, inasmuch as the Lansing strain from primates must be passaged through cotton rats before it produces infection in mice. Perhaps the enzyme systems in the cotton rat and monkey support poliomyelitis virus proliferation more easily; there is a larger "margin of survival" with correspondingly decreased possibilities to effect a critical degree of inhibition.

The enzyme system of the host cells upon which each particular intracellular organism depends must be identified and inactivated by enzyme inhibitors. Metabolic studies such as those by Kabat and others (*J. exp. Med.*, 1944, **80**, 247; 1942, **76**, 579) may point the way. Host cell enzyme inactivation can be achieved biologically (virus interference) as well as chemically (vitagonists, amino acid homologues). Viral enzyme inactivation can be effected by penicillin and possibly sulfonamides. An approach along these lines, although hypothetical, may be in a promising direction. (J. K. Frenkel, *University of California Medical School, San Francisco.)*

TECHNICAL PAPERS

Radiocarbon From Cosmic Radiation[1]

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It has recently been suggested (*2*) that neutrons produced by cosmic radiation should form radiocarbon by the reaction $N^{14}(n,p)C^{14}$ in such amounts that all carbon in living matter (and in other chemical forms in exchange equilibrium with atmospheric CO_2 on a 5,000-year time scale) should be radioactive to the extent of 1–10 disintegrations/minute/gram. In view of the 5,000-year half-life of radiocarbon (*3*, *4*), it was further expected that it should be absent from such geologically "old" carbon sources as petroleum, coal, or limestone. The existence of such "cosmic radioelements" was anticipated by one of us (*1*) shortly after the discovery of artificial radioactivity.

These predictions were investigated by examining the radioactivity of two series of isotopically enriched samples of methane. The first series was derived from petroleum methane (referred to as petromethane) and the other from methane from the Patapsco Sewage Plant of the city of Baltimore (referred to as biomethane).

Measurements on the enriched biomethane samples established the activity of "living" carbon to be 10.5 disintegrations/minute/gram, in good agreement with the predicted value. On the other hand, enrichment of the petromethane by a factor of 25 failed to show activity beyond the limits of experimental error, in line with the theory that cosmic rays produce our activity.

The two methane thermal diffusion plants located at the Houdry Laboratories were used. Six hundred l. of biomethane were necessary to obtain about 20 l. of 12 per cent $C^{13}H_4$; these were purified in a high-vacuum system and reconcentrated to 65–70 per cent $C^{13}H_4$. Experimental values of $C^{13}H_4$ separation were used to determine the operating constants of the thermal diffusion columns. Upon extension of the separation theory to $C^{14}H_4$ concentration, the C^{14} enrichment was calculated, jointly with D. Tanguy, of Houdry's Special Projects Division, using these constants. The over-all error in the computed factor was probably about 20 per cent.

Possibilities of contamination were essentially excluded by running the plants and purification apparatus alternatively with bio- and petromethane, as indicated by the take-off dates of Table 1.

The samples were measured in a brass-cylinder Geiger counter, with glass heads, of 1,900-cc. volume, surrounded by 1.5-inch-thick lead shield to reduce the background. Alternate readings were taken at 6.5 cm. Hg pressure with the two series of samples. A standard external sample of U_3O_8 was used to check that the counter sensitivity was the same for all fillings.

TABLE 1

Source	Sample No.	Calculated C^{14} enrichment	C^{13} concentration from mass spectrometer (%)	% CH_4 in gas before final purification	Date taken	Total count rate, including background (disintegrations/minute)
Petromethane	I	1	1.04	99.6	10/16/46	340.6 ±1.0
	II	1	1.04	99.6	"	342.6 ±1.0
	III	25	6.55	97.2	1/ 6/47	345.8 ±1.3
Biomethane	III	1	1.04	99.4	12/ 5/46	342.9 ±2.0
	I	10	7.36	93.6	10/17/46	348.7 ±1.3
	VII	32	11.02	99.9	12/ 2/46	364.0 ±1.5
	VIII	260	63.5	97.2	2/10/47	562.0 ±2.9

Our data are given in Table 1. There is no significant activity in the petromethane, whereas the biomethane has a definite, easily measurable activity increasing linearly with the calculated C^{14} enrichment.

To eliminate the possibility that the activity was due to tritium, the most concentrated methane, sample Bio VIII was burned and converted to $CaCO_3$. The activity of the $CaCO_3$, as measured in a screen wall counter, established the radioactivity as carbon rather than hydrogen. Further identification of this radioactivity was obtained by a measurement of its absorption in aluminum, which agreed with that of synthetic C^{14}. The data thus establish the activity as being carried in carbon in a molecule of mass 18, present in the original biomethane in very low concentration. The agreement of the absorption data with those for C^{14} further confirms the identification of the activity with C^{14}.

The possibility that the C^{14} found in Baltimore sewage is due to contamination is not entirely excluded, although it is remote. Our sample was taken on September 2, 1946, at which time, according to P. C. Aebersold, no C^{14} from the Atomic Energy Commission had been received by anyone in Baltimore. The possibility of its origin from the atomic piles or bombs is excluded when one realizes that our activity corresponds to the existence in nature of some 10^8 curies, or 20 metric tons—an amount far larger than any synthetic source could have produced to date.

The discovery of cosmic-ray carbon has a number of interesting implications in the biological, geological, and meteorological fields; a number of these are being explored, particularly the determination of ages of various carbonaceous materials in the range of 1,000–30,000 years.

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[1] The authors are grateful to George E. Finck and R. J. Trautman, Department of Public Works of the city of Baltimore, to H. G. Swope, secretary of the A.C.S. Committee on Water, Sewage, and Sanitation, and to Abel Wolman, Johns Hopkins University, for their cooperation; to the Sun Oil Company for the use of its thermal diffusion columns; to W. H. Johnston for assistance in the counting measurements; and to J. T. Dooley for technical assistance.

This investigation is continuing with other sources of carbon and is being extended to other possible cosmic radioelements. A more detailed report will be published elsewhere.

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Fowl Spirochetosis Transmitted by *Argas persicus* (Oken), 1818 From Texas[1]

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Hoffman, Jackson, and Rucker (*4*) have given a preliminary report of spirochetosis in turkeys in California in which no vector was found, although a careful search was made in all poultry houses. This spirochetosis manifested itself in a mild nature compared with that reported by various investigators in other parts of the world. The symptoms were: standing or sitting with the eyes shut, anorexia, loss of weight, and diarrhea. More severe cases walked with difficulty. In a later paper, Hoffman and Jackson (*3*) reported the pathological effects of the spirochete in fowl. The epizootiology of the disease in the flock remained unknown.

Steinhaus (*7*) reported the isolation of an unidentified spirochete from hen's eggs after inoculation with liver tissue from hens raised in Montana. This spirochete was not pathogenic for chickens—a fact which may indicate a difference from the known infectious agent of fowl spirochetosis.

Marchoux and Salimbeni (*6*) showed that the common fowl tick, *Argas persicus*, is a vector of *Borrelia anserina* (Sakharoff) (= *Spirochaeta gallinarum* Blanchard), the agent of fowl spirochetosis. This was verified by the work of Balfour (*1*) and others. The spirochete is transmitted to the progeny of an infected tick through the egg. Incubation in the fowl, when tick transmitted, takes 4–9 days before spirochetes are demonstrable in the peripheral blood. Recovery from the disease is followed by lasting immunity, but in some outbreaks in the Old World the case fatality has been from 60–90 per cent.

Cooley and Kohls (*2*) report *Argas persicus* of almost worldwide distribution in warm climates and a vector of avian spirochetosis in many Old World regions and in Brazil, Panama, and Cuba in the New World. Hungerford and Hart (*5*) showed that the common red mite of chickens (*Dermanyssus gallinae*) can serve as a vector of the fowl spirochetosis.

In the present studies a white Leghorn rooster, on which a large number of ticks obtained from a poultry raiser in El Paso, Texas, were being maintained, became very ill. Blood smears were not made at first, and later they were negative for parasites. Several hundred progeny from these ticks and a few unfed nymphs and adults were next fed on a white Leghorn pullet. A blood smear from the normal hen was negative with Giemsa stain. In 6 days the pullet was obviously ill, and blood smears were positive for spirochetes. On the 7th day many spirochetes were present in blood smears, and a few were still present in the peripheral circulation on the 8th day. After the 8th day no spirochetes were found in blood smears.

Symptoms of the spirochetosis were: jaundice, anorexia, and diarrhea, with loss of weight. The rooster exhibited symptoms of partial paralysis. Both birds tended to sit and droop the head with the eyes shut. Recovery was uneventful in each case. It is believed that this is the first finding of tick-borne avian spirochetosis in the United States.

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A Growth Inhibitor and a Growth Promotor in Sugar Cane[1]

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In connection with a study of structural development in sugar cane, a series of investigations was begun on the growth-regulating substances produced by that plant. In order to find a method by means of which the substances from all tissues of the plant, chlorophyllous as well as nonchlorophyllous, would be extracted, several methods of extraction and analysis described in the literature were tried. The results were unsatisfactory, however. When the direct ether extraction method of Boysen-Jensen was used, the chlorophylls, easily extracted from the green tissues of sugar cane, caused undesirable coagula which interfered with the accurate assay of growth substance in the *Avena* test. Van Overbeek, *et al.* (*10, 11*) applied this method to node and internode tissue of sugar cane stem, where apparently little or no chlorophyll was extracted. Furthermore, in all instances in which tissue was extracted with ether or with water, the sets of coleoptiles showed mixtures of curvatures, some positive toward the agar block and some negative. Since it was thought that such curvatures could not be averaged to give results of any significance, a series of experiments was begun to determine the source of the positive curvatures.

The presence in plants of substances which prevent the growth of the *Avena* coleoptile and cause positive curvatures in the *Avena* assay has long been suspected, but only in relatively recent years have direct evidences of the production of at least one substance been obtained. These evidences indicate that growth-inhibiting substances are produced in a large number of plants and perhaps in all plants. They seem to be produced in quantities varying in relation to the quantities of growth-promoting substances; they may cause little or great interference in growth substance assays and may easily be overlooked when present in small quantities.

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[1] Published with the approval of the director as Technical Paper No 154 of the University of Hawaii Agricultural Experiment Station.

Goodwin (*4*) reported evidence for the presence of inhibiting substances in ether extracts of plant tissue. Diffusion coefficients of auxins extracted by ether did not agree with the theoretical coefficient for auxin a or b. He concluded that this discrepancy was due not to an auxin of different molecular weight but to substances which partially masked the biological effect of auxin on the *Avena* coleoptile.

Stewart (*9*) found a substance in the cotyledons of radish plants which caused positive curvatures of oat coleoptiles. The inhibitor reduced the degree of negative curvatures when extracts of it were mixed with 3-indole acetic acid. Stewart concluded that the *Avena* test would give curvatures that would be correct measures of neither auxin nor inhibitor if both were present in the extract.

Van Overbeek (*10*), using direct ether extraction of nodal and internodal tissue of sugar cane, found that heating tissues in boiling water caused the liberation of a substance that had an inhibitory effect on the curvature of the *Avena* coleoptile. Fresh tissue frozen with solid carbon dioxide and then extracted with ether appeared not to yield the inhibitor.

Because Avery, Berger, and White (*1*) and Shalucha (*8*) have been able to obtain high yields of growth-promoting substance from several kinds of plants with the use of aqueous extraction of lyophilized leaf tissue, and because DuBuy (*3*) obtained good results with water extracts of tissue frozen with solid CO_2, it was decided to try water as primary extractant. It was decided also to attempt two ether extractions, one from neutralized water extract and another subsequent one from the same water extract acidified. A single test on ether extraction from acidulated distilled water yielded a majority of positive curvatures in our sets of coleoptiles. At about this time Larsen (7) published the results of his work leading to the identification of 3-indole acetaldehyde as a neutral growth substance, inactive in the *Avena* test, that could be converted to 3-indole acetic acid by action of soil or of the Schardinger enzyme of milk.

The method now used, after several modifications, is given below. No experiments to determine the thoroughness of extraction have been performed, nor have attempts to identify the substance been made. The data are presented as averages of degrees of curvatures of the coleoptiles and are to be considered at this stage of the investigation as qualitative only.

MATERIALS AND METHODS

The plant material used was taken from nodal and internodal tissue and young leaves of a sugar cane hybrid.[2] Stem material consisted of internodes within or, in some experiments, just below the spindle cluster. Leaf material was comprised of blade tissue of leaves 3, 4, and 5, numbering from the first visible leaf of the spindle cluster (numbering method of Clements, *2*).

The "deseeded" *Avena* assay method of Skoog was used, with two decapitations and a 5-hour photographing period. All work with the coleoptiles proceeded in a specially constructed dark room in which temperature was maintained at 25°–26°C. and relative humidity at 90–91 per cent. Light was supplied by neon in ruby glass tubing mounted over the work table. This provided bright red light of wave lengths above 6,000 A.

The first experiments were carried out utilizing only 50 or 100 mg. of fresh tissue. This quantity was increased weekly until a sample of 200 grams of fresh weight produced significant curvatures in the *Avena* test. All subsequent extractions were made on 200 grams of fresh tissue. The tissue was treated as follows:

(1) The sample, of green or of nonchlorophyllous tissue, was cut as rapidly as possible into pieces 4 mm. or less on a side. The cutting process was performed on a slab of solid CO_2, which not only accomplishes quick freezing but also facilitates cutting succulent tissue.

(2) The sample was separated into approximately equal quantities, each quantity then being placed in dry ice and kept in the frozen state for approximately 20 hours. The quick freezing seemed to facilitate extraction of the growth substances.

(3) The jars were opened, the frozen tissue covered with distilled water (pH 5.5) at room temperature, and the sample muddled with a glass pestle or thick stirring rod, a few small pieces of dry ice being added from time to time to create a carbon dioxide atmosphere. This ostensibly reduces the chances of possibly undesirable oxidation. It also markedly reduces the tendency of the tannins to oxidize to pigmented compounds, and the water is agitated by the bubbling of the CO_2 gas, thereby effecting a constant stirring.

(4) After two hours the water was decanted into a Buchner funnel, and more distilled water was put on the sample and allowed to extract for one-half hour more. The water was decanted into a Buchner funnel, and the residue was washed once, squeezed by hand through a double thickness of cheese cloth, and placed in another sample bottle for further treatment as desired.

(5) The water extract was filtered in several flasks, the number depending upon the volume of water. With the large samples used in these experiments the water extract was usually between 800 and 1,000 ml. in volume when the filtrates were combined and the flasks rinsed with distilled water.

(6) The water extract was then neutralized with 8 per cent (saturated) $NaHCO_3$ solution. No glucose was added because of the high sucrose content naturally resulting from the cane tissue. Between 5 and 10 ml. of bicarbonate is usually sufficient, and the solution, when checked with the Macbeth pH meter, reads pH 7–7.3.

(7) The neutralized extract was placed in separatory funnels and covered with approximately equal volumes of freshly distilled diethyl ether. Emulsifying substances, usually finely suspended particles of tissue, were sometimes included in the water extract, necessitating use of a swirling motion and avoidance of shaking. It is often unavoidable that a coagulum

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[2] *Saccharum officinarum* variety H-32-8560 crossed with unknown pollen. The seedlings were supplied through the courtesy of A. J. Mangelsdorf, Experiment Station, Hawaii Sugar Planters' Association.

containing ether results; when this occurred, the coagulum, which formed on top of the ether layer, was drawn off last and centrifuged to remove ether. The centrifuged residue was washed again with ether and the ether added to the larger ether extract. After the water was drawn off, the ether was allowed to run into a beaker. The water was then put back to the separating funnel and the process repeated. After a third repetition, the three ether extracts were combined, making the neutral fraction.

(8) To the water, which increases somewhat in volume by solution of some ether, was added, with stirring, a quantity of 15 per cent tartaric acid. The electrodes of the pH meter were kept in the extract, acid being added until pH 4 was reached. The water extract was then ether-treated as described in (7).

(9) Each ether extract was evaporated to 1 ml. in water by placing the beaker on a hot plate with very low heat and directing the current of air from an electric fan across the open top. During evaporation the ether was transferred successively into small beakers and finally into shell vials marked for 1-ml. volume. Each beaker was rinsed with a small quantity of ether. If there was not enough residual water, distilled water was added to make a volume of 1 ml.

(10) The 1-ml. extracts were combined in the vials with 1 ml. of 3 per cent agar, warmed sufficiently to be fluid, the solution then being mixed by gentle shaking and poured into a mold, constructed (of glass microscope slides glued to a lantern slide glass) to permit adjustment of the agar level to a 2-mm. depth. Rectangles of the gelled agar were cut in the cutting frame with a razor blade into cubes of 8-mm.^{3} volume, for use in the *Avena* test.

RESULTS

In all experiments in which this procedure was followed, mixtures of significant curvatures were obtained. Representative results are given in Tables 1 and 2.

TABLE 1

CURVATURES OBTAINED WITH 200 GRAMS FRESH SUGAR CANE STEM IMMEDIATELY BELOW SPINDLE CLUSTER*

	No. of coleoptiles	Degrees maximum curvature	Degrees minimum curvature	Average
Experiment 1				
Acid fraction	12	+9	+3	+6.7
Neutral fraction	12	−23	−4	−9.3
Experiment 2				
Acid fraction	14	+24	+6	+13.7
Neutral fraction	17	−11	−2	− 4.2
Experiment 3†				
Acid fraction	22	+8	+2	+ 4.8
Neutral fraction	24	−21	−7	−12.4

* Different samples of sugar cane of mixed and various ancestry were used in each experiment. The data may therefore not be comparable.

† Part of an experiment with young stem tissue.

Although no other tests were made to substantiate the data of Table 2, it appears that with the material used there is evidence of a much greater amount of inhibitor than of growth promotor. These tissues were obtained from upright, growing sugar cane with dormant axillaries. No tests have been made with regard to thorough or prolonged extraction, and the assumption that our data represent extraction of free growth substances is based upon the results of Van Overbeek's experiments (*10*), where it appears that most of the free auxins "are extracted within the first half-hour."

The growth-inhibiting substances in Table 1 are in approximately the same concentration as those in Table 2, but the growth-promoting substances are in much greater quantity than indicated in Table 2; and in Table 1 (Experiments 1 and 3) the growth-promoting substances are in greater concentration than the growth inhibitors in the same plant material.

CONCLUSIONS

No attempts have been made to report these data on bases of total degrees curvature, indole acetic acid equivalents, or any of the other units found in the literature. The method used is not yet developed to the stage where accurate, reproducible results may be obtained. It is our opinion that until a better knowledge is gained of the substances being dealt with in sugar cane, reporting of results on a quantitative basis has little significance. The material used to date was taken from hybrid cane the male parent of which is not known; the stand is therefore made up of many strains, often evidenced by distinct color differences, hairiness, and other superficial characters. The quantity of growth substances may vary among plants, and the relative proportion of the two kinds may vary within the plants. Future studies will be made upon plants of one variety.

TABLE 2

CURVATURES OBTAINED WITH 200 GRAMS INTERNODE, ROOT BAND, AND INTERCALARY MERISTEM TISSUES OF SUGAR CANE

Tissue	Fraction	No. of coleoptiles	Degrees maximum curvature	Degrees minimum curvature	Average
Internode	Acid	18	+9	+3	+4.7
	Neutral	22	−7	−1	−3.1
Root band	Acid	19	+15	+2	+6.2
	Neutral	15	−5	−1	−1.6
Intercalary meristem	Acid	14	+6	+2	+3.6
	Neutral	18	−4	−1	−2.4

The growth substances of a plant form a complex system not analyzable by a simple procedure. At least three groups or categories are now known. These are: (1) growth-promoting substances, which produce negative curvatures in the *Avena* test. Auxenolonic acid, auxentriolic acid, and 3-indole acetic acid are known to be produced in higher plants; (2) neutral growth substances, the presence of which in plants has been demonstrated by Larsen (*6, 7*) who identified one as 3-indole acetaldehyde and has evidence that this substance, inactive in the *Avena* test, is converted by aldehydrases to 3-indole acetic acid; and (3) growth-inhibiting substances, which produce positive curvatures in the *Avena* test. Presence of this kind of growth substance has been demonstrated by Larsen (*6*), Kisser (*5*), Stewart (*9*), and others in tissue which apparently was relatively low in growth-promoting substances. The nature of these compounds, or their relationship to the others, is not yet known, but Stewart (*9*) presents evidence indicating that the inhibitor of radish cotyledons may be hydrolyzed to growth-promoting substance.

It is clear, then, that a satisfactory extraction technique must somewhere provide for the separation of the *two* groups of growth substances which are active in the *Avena* test. Unless this is done, the *Avena* assay can only approach reasonable accuracy when either group of substances is extremely low in relation to the other.

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Comparative Nutritive Value of Casein and Lactalbumin for Man

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The classic work of Osborne and Mendel (*5*) showed that casein is deficient in cystine and that its companion protein, lactalbumin, is superior in promoting the growth of rats. This finding was promptly (and at that time, perhaps, properly) used in partial explanation of the superiority of breast milk over cow's milk in the feeding of infants (*2*). In confirmation of these early observations, we have recently reported (*1*) that the addition of methionine to an enzymic hydrolysate of casein (amigen) resulted in an accelerated rate of growth in rats, and when the supplemented hydrolysate was given intravenously, it improved nitrogen retention in dogs. When the same type of supplementation studies were made in humans, there was no improvement in nitrogen retention. Four groups of humans were employed: (1) surgical patients fed intravenously, (2) normal infants, (3) normal adults on a maintenance nitrogen level, and (4) normal adults who were protein depleted and fed just enough nitrogen to supply the approximate endogenous needs. Methionine supplementation did not increase the efficiency of nitrogen utilization from the casein hydrolysate.

These findings naturally led us to determine the comparative effectiveness of intact casein and of lactalbumin in promoting nitrogen retention *in man*. Four normal adults were placed on a protein-low diet (*4*) for 12 days, until a constant nitrogen excretion (assumed to be approximately endogenous) had been reached. The nitrogen intake during all depletion periods was 0.008 gram/kg. body weight/day, and for the last 4 of the initial 12 days the average nitrogen loss was 3.22 grams daily. The caloric intake during the entire 40-day study was maintained constantly at 40 calories/kg. body weight.

Four-day periods of supplementation with either casein or lactalbumin were then alternated with 4-day depletion periods. The two proteins were fed alternately, and each was administered for two 4-day experimental periods in order to minimize the effect of antecedent conditions on nitrogen balance. A level of supplementation insufficient to produce positive nitrogen balance was intentionally chosen. This level was 0.033 gram of nitrogen/kg. body weight as the test protein, equal to 2 per cent of the total calories. The average nitrogen balances for each subject for each period are given in Table 1. Subject C contracted a mild type of prevalent "influenza" and could not complete the test.

TABLE 1

Nitrogen Balances for Each Period

(Data expressed in grams nitrogen/day)

Periods (4 days each)	Subject				
	A	B	C	D	Avg.
Depletion	−3.92	−2.26	−3.81	−2.90	−3.22
Casein	−.76	−.64	−.83	−.93	−.79
Depletion	−4.13	−2.88	−3.52	−3.00	−3.38
Lactalbumin	−.65	−.47	−.69	−1.40	−.80
Depletion	−3.48	−2.29	−2.81	−2.75	−2.83
Casein	−.74	−.32	−.87	−.79	−.68
Depletion	−4.09	−2.10	—	−2.34	−2.84
Lactalbumin	−1.44	−.05	—	−.66	−.72

These experiments reveal no significant difference between the two proteins in maintaining nitrogen balance in man. The average endogenous value for the four depletion periods was −3.07 grams. The addition of casein spared 2.33 grams of body nitrogen, and the addition of lactalbumin, 2.31 grams. These average values are closer than might again be encountered, but the individual balances were within the range of variation that we have observed in this type of study. All pertinent details of the study will be published elsewhere.

We have approached the calculation of "biological value" with temerity, since, in our experience, such comparative values more often mask than disclose information. Using an average for the four depletion periods as the endogenous level of urinary and of fecal nitrogen excretion, average "biological values" are: for casein, 89.0 and 94.7, respectively; for lactalbumin, 90.2 and 93.3. In spite of the similarity in these final average figures, it should be noted that the variation in the individual values is as great as that observed in experimental animals (*3*).

We have attributed the failure of methionine to improve the nitrogen retention of a casein hydrolysate in man to the fact that man is not covered with hair. Hair contains a high percentage of cystine, and it is logical that the requirement of the rat and the dog for sulfur-containing amino acids should be greater than that of man (*1*). Whether or not this explanation is valid, these data demonstrate that lactalbumin is not superior to casein in promoting nitrogen retention in man.

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IN THE LABORATORY

Simple Syringe Burette[1]

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The use of a syringe for rapid and highly accurate delivery of fluids was introduced by Krogh and Keys (*1*), and their syringe pipette has since come into wide use. The less accurate syringe burette, described herein, and the titration procedure were developed primarily for field use. The equipment is compact and easy to operate, and gives an accuracy within 0.5 per cent for conventional titrations. The burette can also be used as a constant delivery pipette with a routine accuracy for total delivery of 0.1 per cent. The plunger can be removed at any time for cleaning without disturbing the setting of the instrument.

The burette (Fig. 1) consists of a standard 1-cc. tuberculin syringe on which is fused a 5-cm.-long, tapered delivery tip. The barrel of the syringe is provided with a split plastic block which can be clamped onto it by means of two screws (A). A straight-angle bow of stainless spring steel wire, 0.5–0.7 mm. in diameter, is press fitted into the block. The bow is so adjusted as to press slightly onto the plunger of the syringe to give it the necessary friction for a smooth operation. The plunger is notched (C) to engage the spring wire clip in order to furnish the automatic zero point. This notch is cut perpendicular to the axis of the plunger by means of a sharp-edged, triangular, medium or fine India oil stone. The cut must be sharp and straight and fit the spring steel bow without play. The notch should be located in line with the number on the plunger in order to orient the plunger regularly.

When used as a burette, it is necessary to grind the end of the plunger flat and perpendicular to the axis in order to obtain a parallax-free reading of the instrument. The grinding is performed in a block of bakelite provided with a series of holes of slightly different size. The plunger is placed in the best-fitting hole, and the block, together with the plunger, is ground against a piece of emery paper resting on a flat surface.

A split cork on the syringe barrel serves to unite the burette with the titration vessel (B).

To adjust the automatic zero setting of the burette, the syringe burette is filled with water and the block (A) loosened; while the spring engages the notch (C), the block is set so that the end of the plunger reads exactly 100. A lens should be used for reading. The graduation is calibrated by weighing the water delivered by, for example, 95 divisions, evaporation losses being most simply avoided by delivery into a tall and narrow, open weighing vial which is handled by forceps to avoid temperature gradients (*2*).

For constant delivery the plunger is moved down from the notch until it bottoms with the notch (and number) facing the bow. The end of the plunger must be ground flat, as described above, but it is left with a blunt edge so that it does not stick when moved to the bottom. The delivery is determined by weighing as described. Seven different syringe burettes were tested in this way. Out of 35 consecutive weighings, 32 agreed within ± 0.1 per cent or better.

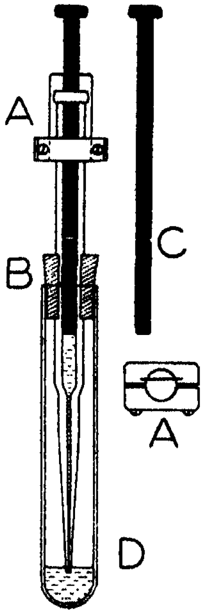

FIG. 1. Syringe burette attached to titration vial: A, plastic block with spring clip; B, split cork for uniting burette with titration vial (D); C, notch in plunger which engages spring wire (A) when the end of the plunger is at zero point of the syringe scale.

The sample to be titrated is delivered in the desired volume from a syringe or other accurate pipette directly to the bottom of the titration vial, without leaving drops sticking to the wall.

With the burette full of titration fluid (*i.e.* with the spring engaged in the notch), it is then inserted in the titration vial and fastened by means of the split cork. The tip of the burette is moved close to the surface of the sample, or slightly below, if the specific gravity of the burette fluid is lower than that of the sample.

While the whole unit is being agitated, the plunger is held by the button and moved slowly downwards by a screwing motion until titration is complete.

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[1] This method was developed in connection with work on Cost Reimbursement Scientific Research and Development Contract No. W33-038-ac-14985, between the Air Materiel Command, Wright Field, and Swarthmore College (Department of Zoology).

[2] The writer is indebted to Dr. Laurence Irving for help and advice during this work. The tuberculin syringes were adapted for the present use by J. D. Graham, Department of Physiology, University of Pennsylvania.

For reading, the syringe is detached from the vial and the scale read by sighting across the flat end of the plunger and estimating to the nearest fifth or quarter of a division, again using a lens.

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Improved Technique for Enumeration of *Escherichia coli* on Black Walnut Meats[1]

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The enumeration of microorganisms found on solid materials is, in the main, based on their removal by washing a known weight of the solids with a known volume of washing fluid and then making serial dilutions from this fluid prior to the use of one of the common modes for determining numbers.

In the course of an investigation on the effectiveness of pasteurization for killing *Escherichia coli* on inoculated black walnut meats, it was found that washing the meats to remove the bacteria was not satisfactory when the Halvorson-Ziegler (*1*) method of determining the "most probable number" (MPN) of bacteria was used. The number of positive tubes found in the 10 replicate tubes of each of the three lowest dilutions gave codes which, when applied to the probability table, were equivalent to such "MPN" values as to make it evident that the seeding of the solid itself was needed if more accurate codes were to be secured.

Accordingly, an attempt was made to use the meats themselves in the replicate plantings, so that one member of the resultant code would be of no dilution. This was accomplished by cutting a known weight of the meats into small particles in a sterile Waring blendor container. After a homogeneous mass was secured and 10 replicate 1-gram samples had been removed for planting into lactose broth fermentation tubes, a known volume of sterile water was added to the container and the mixture further agitated until a creamy mass was secured. This material could be pipetted easily in making the 10 replicate plantings from this dilution, and it could also serve as the starting point for making subsequent dilutions.

TABLE 1

Test	MPN/gram	
	Washed meats	Blendor-treated meats
1	0	0.7
2	0.9	275.0
3	0	240.0
4	0	1.6
5	0	7.9
6	0	16.9
7	3.2	130.0

The results of typical tests made on inoculated meats which had received various heat treatments are shown in Table 1. This table contrasts the "MPN" of *E. coli* per gram of meats when washing was used for the removal of these organisms with the "MPN" gained by the use of the Waring blendor procedure. Meats from the same batch were used when comparing the procedures.

TABLE 2

Test	MPN/gram	
	Washed meats	Blendor-treated meats
1	6,220	11,600
2	24,400	39,900
3	2,900	4,930
4	3,900	9,200
5	11,400	32,900
6	1,960	4,840
7	7,420	34,900

The superiority of the Waring blendor procedure is shown also in Table 2. Inoculated nut meats which had not been heat treated served as source material for contrasting the two modes of removal. Meats from the same batch were used when comparing the procedures.

The results of these tests suggest that, where the solid lends itself to subdivision, the use of the Waring blendor for this process permits the seeding of homogeneous, undiluted solid material into the tubes of broth. This procedure, together with the actual "carrying over" of the solid into subsequent dilutions, makes for a greater recovery of the organisms than that secured by washing the solid materials.

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[1] Published with the approval of the director, West Virginia Agricultural Experiment Station, as Scientific Paper No. 369.

Cultivation of Microorganisms With the Aid of Cellophane Membranes

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This brief report describes the use of thin sheets of cellophane for the cultivation of bacteria and fungi. We first used cellophane for this purpose during the German occupation, when Petri dishes were unobtainable.

A sheet of cellophane was rolled around a rod and sterilized by autoclaving. It was then unrolled on a table, and melted agar medium was poured out over the sheet. The surface was inoculated by spraying, and the agar immediately covered by a second cellophane sheet. To save space, the whole culture was finally rolled up again loosely around the rod and incubated.

Recently we have taken up the problem from another side, using the cellophane sheets not only as a substitute for glass but as a dialysing membrane. These sheets are impermeable to bacteria and viruses, but they allow the passage of water and solutes (except those of very large molecular weight). Thus, colonies of bacteria can be grown on one side of the cellophane, nourished by fluid, which dialyses through from the opposite side of the membrane.

In our first experiments we used cellophane tubes (available as sausage skins), as shown in Fig. 1.

For the production of thick, slimy cultures on the inner side of the cellophane tube (Fig. 1a), the tube (1) is pulled over the ends of two glass tubes (2) of the same diameter and fastened to them at each end by collodion. Through the tube is passed a very slow current of air under a slight pressure, sufficient to keep the tube rigid. Through the narrow space between the cellophane tube and an outer, enveloping glass tube (3) is circulated a slow stream of the nutrient solution. All the tubes are fitted tightly in rubber stoppers (4) as shown. The culture is now growing on the inner surface of the cellophane tube, nourished through the cellophane but not contaminating the broth. As soon as the growth becomes luxurious, the culture drips down along the tube and is collected in a container (5).

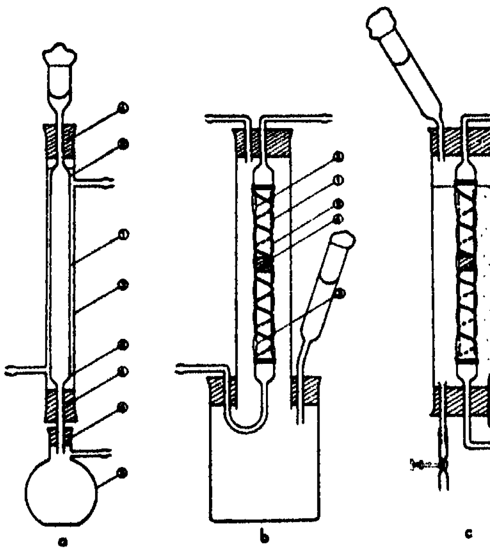

FIG. 1. The three main arrangements for experiments with cellophane tubes.

With the apparatus shown in Fig. 1b the same end is attained in a slightly altered manner. Here the culture grows upon the outer surface of the cellophane tube (1), while the nutrient broth circulates between the cellophane and a narrower glass tube (2) inserted in the cellophane tube. To prevent the cellophane from sticking to the surface of the inner glass tube, a string is wound spirally around the cellophane tube. The current is thus forced to circulate spirally around the inner tube. The nutrient solution is fed and drained off through the inner tube, which has two small openings (3) near the top and the bottom but is closed by a rubber stopper (4) between these openings.

In the third type of apparatus, shown in Fig. 1c, the culture grows not upon a cellophane surface in an air-filled space but in a nutrient broth with aeration only by a stream of filtered air, this gives a fluid, but finally very thick, culture.

This method of cultivation is of use when large amounts of bacteria (free from substrate protein) are required (e.g. rhizobia for the inoculation of leguminous plants). It has the added advantage that the culture can be grown without interruption and, if the nutrient broth is renewed from time to time, for an unlimited period. Furthermore, this principle may also prove to be of use for the study of bacterial products, which can thus be obtained free from substrate protein in the dialysate.

Our first experiments proved that the method was sufficiently productive. The apparatus shown in Fig. 1 (a or b) gave within 10 days, at 29° C., 15 grams of a rather stiff, slimy culture of *Rhizobium* of a quality similar to that derived from agar-plate culture, the total surface of the cellophane tube being 100 cm.^{2}, while the surface of agar plates for production of the same amount in similar circumstances would be nearly 150 cm.^{2}.

We do not know whether others have used cellophane in culturing bacteria or studying their metabolism; recently we have found a short communication (*1*) on the interaction of different bacteria suspended in nutrient solutions and separated from each other by collodion membranes.

The above-described method, of course, does not require that cellophane membranes be used solely. Other types of membranes may be even more suitable for some purposes.

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Laboratory Test of Aviator's Ejection Seat

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Emergency escape from high-speed aircraft is dangerous and sometimes impossible. It is not only difficult for the pilot to leave the cockpit against the force of the wind stream, but he may fail to clear plane structures as he is swept backwards along the axis of flight. In spins he may be unable to move, and at low altitudes there is often insufficient time to abandon the plane in an emergency. The most serious hazard is collision with the tail surfaces after leaving the cockpit.

Development of an ejection seat which instantaneously catapults the pilot from the plane was started in Germany during the last war (*2*) and has been continued and improved by the British (*1*). The U. S. Army and Navy are adapting and developing such devices for service aircraft from which escape is at present dangerous. Each of these groups of workers has successfully ejected aviators from planes in flight under experimental conditions.

Catapulting the seat from the plane provides an escape possibility limited by the dimensions and motion of the plane at the time of ejection and by the tolerance of the aviator to ejection. The primary restriction is the vertical distance in the cockpit available for imparting velocity and direction to the catapulted seat and pilot.

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[1] The opinions expressed in this article are those of the authors and are not to be considered as reflecting those of the Navy Department. Appreciation is expressed to A. T. Kornfield and D. Weiss for the design of the velocity meter and pressure pickup and the operation of the instrumentation for these experiments.

The maximum speed of any particular plane at which the aviator may be safely ejected is determined by human tolerance to rapid acceleration. The physiology of this phenomenon is not well understood. Compression fractures of vertebrae or extrusion of intervertebral disc are believed likely to occur at accelerations, applied from seat to head, of approximately 23–25 times the acceleration due to gravity ("G"). The relations between exposure time and the critical level of acceleration which is likely to cause vertebral damage are not known. A subcritical level of acceleration applied to the seat in an elastic system may result in accelerations above the critical level in integral parts of the system. If this should occur in the spine over significant intervals of time, injury may result.

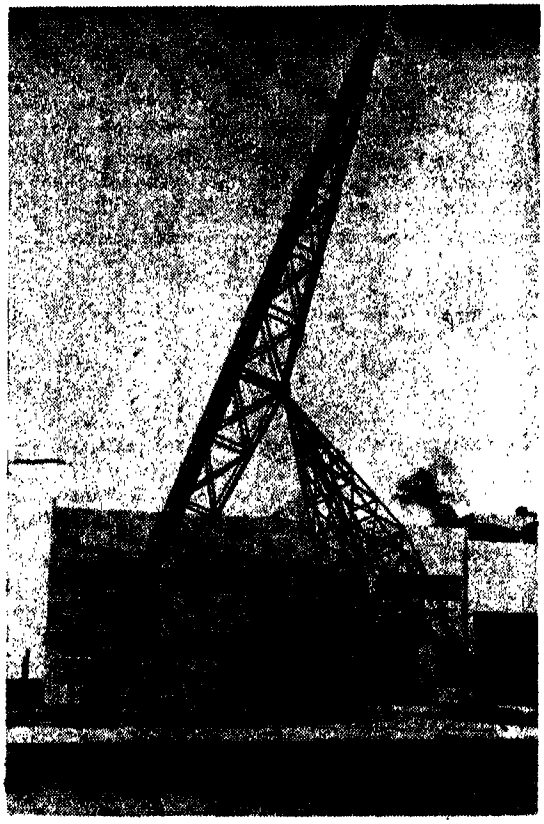

FIG. 1. Side view of 105-foot ejection seat test tower.

Previous investigations, limited by the lack of satisfactory instrumentation and test facilities, have failed to follow events in human subjects exposed to accelerations by high-performance ejection devices. The present study has helped to establish safe methods for the ejection of personnel from high-speed aircraft with a propelling device of limited stroke.

Method. A 105-foot ejection seat test tower and experimental catapult were procured from Martin-Baker Aircraft, Ltd. (Fig. 1). The catapults are cartridge-exploded piston and cylinder tubes 40, 52, and 60 inches long. A subject or dummy, strapped in a conventional aircraft seat with a standard retention harness (Fig. 2), is ejected up guide rails 70° from the horizontal by means of the powder-operated catapult. The charge is fired when the subject pulls a canvas curtain from above the head down in front of the face to the level of the chest. During the following acceleration this curtain partially supports the weight of the arms and shoulders and prevents extreme forward flexion of the cervical vertebrae. The seat is held at the top of the ascent by ratchets and is subsequently lowered by a cable operated from the ground.

Acceleration is measured on the seat and on the subject's hip, shoulder, and head by Statham (Model R-40-450) accelerometers mounted at these points (*Fig. 2*). Catapult pressure is recorded with a strain-gauge pressure pickup. Seat velocity is obtained by means of a coil attached to the seat and passing over magnets spaced at 2-inch intervals parallel to the motion of the seat. Maximum velocity can also be obtained by calculation from the ejection height. All data signals are simultaneously recorded with a Consolidated oscillograph (Model 5-101A).

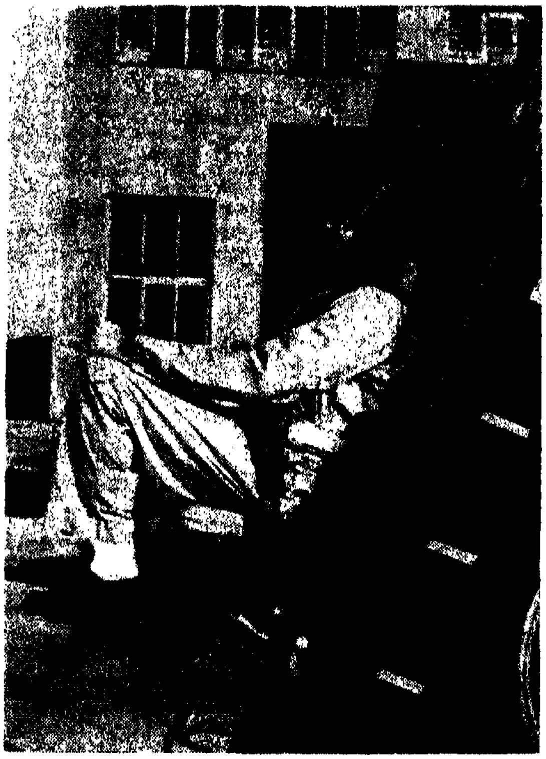

FIG. 2. Subject on test seat with accelerometers secured to hip, shoulder, and head. Handles of firing curtain can be seen above the head.

Since it was expected that vertebral injury could occur with little or no warning, subjects were progressively exposed to increasing accelerations. Three dummy ejections were made for each experimental arrangement. If maximum acceleration did not exceed 21–22 "G", volunteer subjects were then used under the same conditions. The subjects had average physiques and could be considered as a cross section of workers at a research station. Their ages ranged from 19 to 53 years, and weights from 130 to 195 pounds. In addition to preliminary experiments, 48 ejections have been made with 21 subjects, using a standardized charge designed to produce a maximum acceleration of 18–20 "G".

Results. An oscillograph record of an experiment on the test tower is shown in Fig. 3. Average data from representative ejections with each type of catapult are given in Table 1. If any subjective reaction resulted from these high accelerations, it was usually a mild pain in the lumbar, thoracic, or cervical regions followed by a generalized soreness. No injuries have occurred, and individuals could probably tolerate slightly higher accelerations, but 20–22 "G" is believed to represent the practical upper limits for seat ejection experiments. Satisfactory escape devices can probably be developed without exceeding these limits.

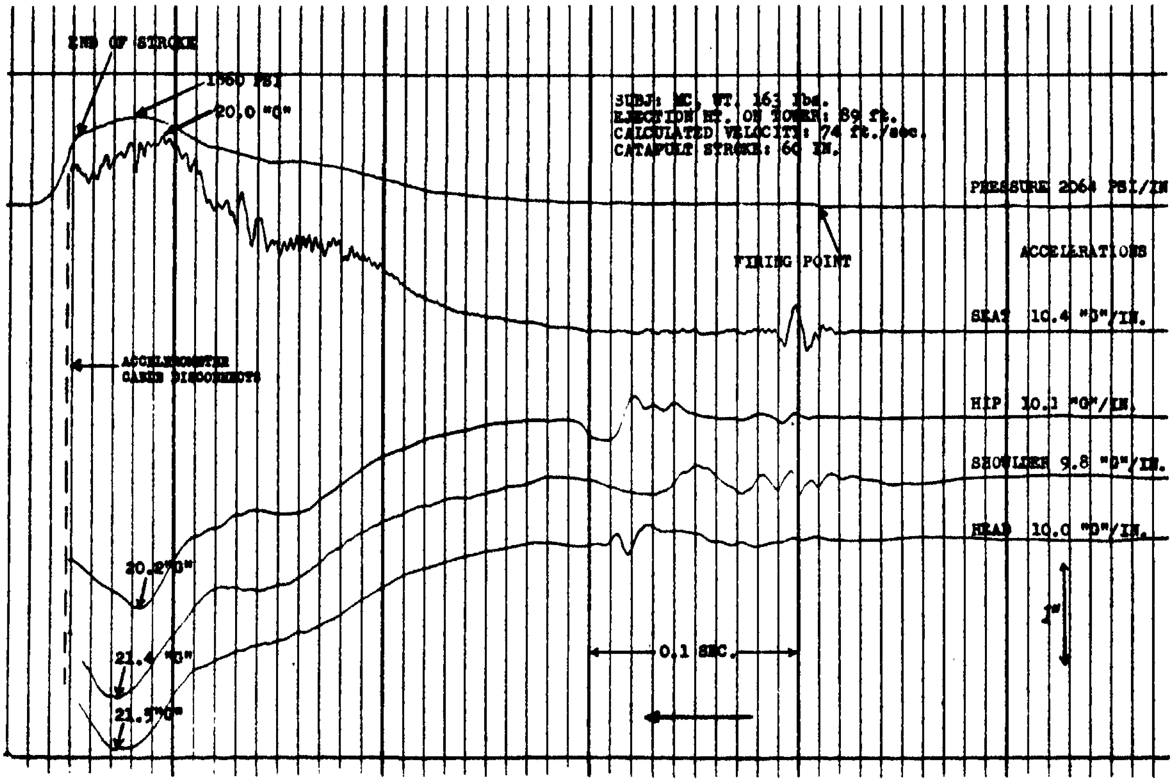

FIG. 3. Oscillograph record showing accelerations recorded on a subject during ejection on test tower.

TABLE 1

No. subjects	Avg. wt. (lbs.)	Catapult stroke (in.)	Avg. seat "G"	Avg. hip "G"	Avg. shoulder "G"	Avg. head "G"	Avg. maximum velocity (ft./sec.)
3	172	40	17.2	17.6	18.4	17.8	55.8
5	164	52	17.8	19.3	17.4	16.6	63.9
4	165	60	19.9	20.3	21.3	19.8	71.2

Additional research is necessary to determine the optimal system for ejection from aircraft. In some of our experiments with catapults producing a range of rates of accelerations, the "overshooting" of "G" recorded on the subject, compared to that recorded on the seat, became progressively greater as the rate of onset of acceleration increased. This excessive acceleration, technically the dynamic factor, is to be expected in a springmass system such as the seat-cushion-man. Compromises may have to be effected between rate of acceleration, maximum level and duration of acceleration, and cushioning devices for seat ejection at the highest velocities which can be safely tolerated in any particular airplane.

It is also believed that myotatic reflexes are important in protecting individuals exposed to high acceleration. Adequate time should be allowed for reflex muscular contraction before reaching a critical level of acceleration. Details of experiments to determine factors affecting man's tolerance to impact-like accelerations will be given in a later publication.

These experiments have shown that under controlled laboratory conditions personnel can be safely exposed to high, impact-like accelerations with a minimum of discomfort. Data obtained can be used for the design and predicted performance of ejection seats for use in aircraft. Using a catapult similar to those tested in the laboratory, an aviator was successfully ejected from a plane at an airspeed of 250 m.p.h. On the basis of laboratory data it is expected that ejections can be made at much higher speeds.

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Natural Selection and the Mental Capacities of Mankind

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THE FUNDAMENTAL MECHANISMS OF the transmission of heredity from parents to offspring are surprisingly uniform in most diverse organisms. Their uniformity is perhaps the most remarkable fact disclosed by genetics. The laws discovered by Mendel apply to human genes just as much as to those of the maize plant, and the processes of cellular division and germ cell maturation in man are not very different from those in a grasshopper. The similarity of the mechanisms of heredity on the individual level is reflected on the population level in a similarity of the basic causative factors of organic evolution throughout the living world. Mutation, selection, and genetic drift are important in the evolution of man as well as in amoebae and in bacteria. Wherever sexuality and cross-fertilization are established as exclusive or predominant methods of reproduction, the field of hereditary variability increases enormously as compared with asexual or self-fertilizing organisms. Isolating mechanisms which prevent interbreeding and fusion of species of mammals are operative also among insects.

Nevertheless, the universality of basic genetic mechanisms and of evolutionary agents permits a variety of evolutionary patterns to exist not only in different lines of descent but even at different times in the same line of descent. It is evident that the evolutionary pattern in the dog species under domestication is not the same as in the wild ancestors of the domestic dogs or in the now living wild relatives. Widespread occurrence of reduplication of chromosome complements (polyploidy) in the evolution of plants introduces complexities which are not found in the animal kingdom, where polyploidy is infrequent. Evolutionary situations among parasites and among cave inhabitants are clearly different from those in free-living forms. Detection and analysis of differences in the evolutionary patterns in different organisms is one of the important tasks of modern evolutionists.

It can scarcely be doubted that man's biological heredity is transmitted by mechanisms similar to those encountered in other animals and in plants. Likewise, there is no reason to believe that the evolutionary development of man has involved causative factors other than those operative in the evolution of other organisms. The evolutionary changes that occurred before the prehuman could become human, as well as those which supervened since the attainment of the human estate, can be described causally only in terms of mutation, selection, genetic drift, and hybridization—familiar processes throughout the living world. This reasoning, indisputable in the purely biological context, becomes a fallacy, however, when used, as it often has been, to justify narrow biologism in dealing with human material.

The specific human features of the evolutionary pattern of man cannot be ignored. Man is a unique product of evolution in that he, far more than any other creature, has escaped from the bondage of the physical and the biological into the multiform social environment. This remarkable development introduces a third dimension in addition to those of the external and internal environments—a dimension which many biologists, in considering the evolution of man, tend to neglect. The most important setting of human evolution is the human social environment. As stated above, this can influence evolutionary changes only through the media of mutation, selection, genetic drift, and hybridization. Nevertheless, there can be no genuine clarity in our understanding of man's biological nature until the role of the social factor in the development of the human species is understood. A biologist approaching the problems of human evolution must never lose sight of the truth stated more than 2,000 years ago by Aristotle: "Man is by nature a political animal."

In the words of Fisher, "For rational systems of evolution, that is, for theories which make at least the most familiar facts intelligible to the reason, we must turn to those that make progressive adaptation the driving force of the process." It is evident that man by means of his reasoning abilities, by becoming a "political animal," has achieved a mastery of the world's varying environments quite unprecedented in the history of organic evolution. The system of genes which has permitted the development of the specifically human mental capacities has thus become the foundation and the paramount influence in all subsequent evolution of the human stock. An animal becomes adapted to its environment by evolving certain genetically determined physical and behavioral traits; the adaptation of man consists chiefly in developing his inventiveness, a quality to which his physical heredity predisposes him and which his social heredity provides him with the means of realizing. To the degree to which this is so, man is unique. As far as his physical responses to the world are concerned, he is almost wholly emancipated from dependence upon inherited biological dispositions, uniquely improving upon the latter by the process of learning that which his social heredity (culture) makes available to him. Man possesses much more efficient means of achieving immediate or long-term adaptation than any other biological species: namely, through learned responses or novel inventions and improvisations.

In general, two types of biological adaptation in evolution can be distinguished. One is genetic specialization and genetically controlled fixity of traits. The second consists in the ability to respond to a given range of environmental situations by evolving traits favorable in these particular situations; this presupposes genetically controlled plasticity of traits. It is known, for example, that the composition of the blood which is most favorable for life at high altitudes is somewhat different from that which suffices at sea level. A species which ranges from sea level to high altitudes on a mountain range may become differentiated into several altitudinal races, each having a fixed blood composition favored by natural selection at the particular altitude at which it lives; or a genotype may be selected which permits an individual to respond to changes in the atmospheric pressure by definite alterations in the composition of the blood. It is well known that heredity determines in its possessor not the presence or absence of certain traits but, rather, the responses of the organisms to its environments. The responses may be more or less rigidly fixed, so that approximately the same traits develop in all environments in which life is possible. On the other hand, the responses may differ in different environments. Fixity or plasticity of a trait is, therefore, genetically controlled.

Whether the evolutionary adaptation in a given phyletic line will occur chiefly by way of genetic fixity or by way of genetically controlled plasticity of traits will depend on circumstances. In the first place, evolutionary changes are compounded of mutational steps, and consequently the kind of change that takes place is always determined by the composition of the store of mutational variability which happens to be available in the species populations. Secondly, fixity or plasticity of traits is controlled by natural selection. Having a trait fixed by heredity and hence appearing in the development of an individual regardless of environmental variations is, in general, of benefit to organisms whose milieu remains uniform and static except for rare and freakish deviations. Conversely, organisms which inhabit changeable environments are benefited by having their traits plastic and modified by each recurrent configuration of environmental agents in a way most favorable for the survival of the carrier of the trait in question.

Comparative anatomy and embryology show that a fairly general trend in organic evolution seems to be from environmental dependence toward fixation of the basic features of the bodily structure and function. The appearance of these structural features in the embryonic development of higher organisms is, in general, more nearly autonomous and independent of the environment than in lower forms. The development becomes "buffered" against environmental and genetic shocks. If, however, the mode of life of a species happens to be such that it is, of necessity, exposed to a wide range of environments, it becomes desirable to vary some structures and functions in accordance with the circumstances that confront an individual or a strain at a given time and place. Genetic structures which permit adaptive plasticity of traits become, then, obviously advantageous for survival and so are fostered by natural selection.

The social environments that human beings have created everywhere are notable not only for their extreme complexity but also for the rapid changes to which immediate adjustment is demanded. Adjustment occurs chiefly in the psychical realm and has little or nothing to do with physical traits. In view of the fact that from the very beginning of human evolution the changes in the human environment have been not only rapid but diverse and manifold, genetic fixation of behavioral traits in man would have been decidedly unfavorable for survival of individuals as well as of the species as a whole. Success of the individual in most human societies has depended and continues to depend upon his ability rapidly to evolve behavior patterns which fit him to the kaleidoscope of the conditions he encounters. He is best off if he submits to some, compromises with some, rebels against others, and escapes from still other situations. Individuals who display a relatively greater fixity of response than their fellows suffer under most forms of human society and tend to fall by the way. Suppleness, plasticity, and, most important of all, ability to profit by experience and education are required. No other species is comparable to man in its capacity to acquire new behavior patterns and discard old ones in consequence of training. Considered socially as well as biologically, man's outstanding capacity is his educability. The survival value of this capacity is manifest, and therefore the possibility of its development through natural selection is evident.

It should be made clear at this point that the replacement of fixity of behavior by genetically controlled plasticity is not a necessary consequence of all forms of social organization. The quaint attempts to glorify insect societies as examples deserving emulation on the part of man ignore the fact that the behavior of an individual among social insects is remarkable precisely because of the rigidity of its genetic fixation. The perfection of the organized societies of ants, termites, bees, and other insects is indeed wonderful, and the activities of their members may strike an observer very forcibly by their objective purposefulness. This purposefulness is retained, however, only in environments in which the species normally lives. The ability of an ant to adjust its activities to situations not encountered in the normal habitats of its species is very limited. On the other hand, social organizations on the human level are built on the principle that an individual is able to alter his behavior to fit any situation, whether previously experienced or new.

This difference between human and insect societies is, of course, not surprising. Adaptive plasticity of behavior can develop only on the basis of a vastly more complex nervous system than is sufficient for adaptive fixity. The genetic differences between human and insect societies furnish a striking illustration of the two types of evolutionary adaptations—those achieved through genetically controlled plasticity of behavioral traits and those attained through genetic specialization and fixation of behavior.

The genetically controlled plasticity of mental traits is, biologically speaking, the most typical and uniquely human characteristic. It is very probable that the survival value of this characteristic in human evolution has been considerable for a long time, as measured in terms of human historical scales. Just when this characteristic first appeared is, of course, conjectural. Here it is of interest to note that the most marked phylogenetic trend in the evolution of man has been the special development of the brain, and that the characteristic human plasticity of mental traits seems to be associated with the exceptionally large brain size. The brain of, for example, the Lower or Middle Pleistocene fossil forms of man was, grossly at least, scarcely distinguishable from that of modern man. The average Neanderthaloid brain was somewhat larger than that of modern man, though slightly different in shape. More important than the evidence derived from brain size is the testimony of cultural development. The Middle Acheulean handiwork of Swanscombe man of several hundred thousand years ago and the beautiful Mousterian cultural artifacts associated with Neanderthal man indicate the existence of minds of a high order of development.

The cultural evidence thus suggests that the essentially human organization of the mental capacities emerged quite early in the evolution of man. However that may be, the possession of the gene system, which conditions educability rather than behavioral fixity, is a common property of all living mankind. In other words, educability is truly a species character of man, *Homo sapiens*. This does not mean, of course, that the evolutionary process has run its course and that natural selection has introduced no changes in the genetic structure of the human species since the attainment of the human status. Nor do we wish to imply that no genetic variations in mental equipment exist at our time level. On the contrary, it seems likely that with the attainment of human status that part of man's genetic system which is related to mental potentialities did not cease to be labile and subject to change.

This brings us face to face with the old problem of the likelihood that significant genetic differences in the mental capacities of the various ethnic groups of mankind exist. The physical and, even more, the social environments of men who live in different countries are quite diversified. Therefore, it has often been argued, natural selection would be expected to differentiate the human species into local races differing in psychic traits. Populations of different countries may differ in skin color, head shape, and other somatic characters. Why, then, should they be alike in mental traits?

It will be through investigation rather than speculation that the problem of the possible existence of average differences in the mental make-up of human populations of different geographical origins will eventually be settled. Arguments based on analogies are precarious, especially where evolutionary patterns are concerned. If human races differ in structural traits, it does not necessarily follow that they must also differ in mental ones. Race differences arise chiefly because of the differential action of natural selection on geographically separated populations. In the case of man, however, the structural and mental traits are quite likely to be influenced by selection in different ways.

The very complex problem of the origin of racial differentiations in structural traits does not directly concern us here. Suffice it to say that racial differences in traits such as the blood groups may conceivably have been brought about by genetic drift in populations of limited effective size. Other racial traits are genetically too complex and too consistently present in populations of some large territories and absent in other territories to be accounted for by genetic drift alone. Differences in skin color, hair form, nose shape, etc. are almost certainly products of natural selection. The lack of reliable knowledge of the adaptive significance of these traits is perhaps the greatest gap in our understanding of the evolutionary biology of man. Nevertheless, it is at least a plausible working hypothesis that these and similar traits have, or at any rate had in the past, differential survival values in the environments of different parts of the world.

By contrast, the survival value of a higher development of mental capacities in man is obvious. Furthermore, natural selection seemingly favors such a development everywhere. In the ordinary course of events in almost all societies those persons are likely to be favored who show wisdom, maturity of judgment, and ability to get along with people—qualities which may assume different forms in different cultures. Those are the qualities of the plastic personality, not a single trait but a general condition, and this is the condition which appears to have been at a premium in practically all human societies.

In human societies conditions have been neither rigid nor stable enough to permit the selective breeding of genetic types adapted to different statuses or forms of social organization. Such rigidity and stability do not obtain in any society. On the other hand, the outstanding fact about human societies is that they do change and do so more or less rapidly. The rate of change was possibly comparatively slow in earlier societies, as the rate of change in present-day nonliterate societies may be, when compared to the rate characterizing occidental societies. In any event, rapid changes in behavior are demanded of the person at all levels of social organization even when the society is at its most stable. Life at any level of social development in human societies is a pretty complex business, and it is met and handled most efficiently by those who exhibit the greatest capacity for adaptability, plasticity.

It is this very plasticity of his mental traits which confers upon man the unique position which he occupies in the animal kingdom. Its acquisition freed him from the constraint of a limited range of biologically predetermined responses. He became capable of acting in a more or less regulative manner upon his physical environment instead of being largely regulated by it. The process of natural selection in all climes and at all times have favored genotypes which permit greater and greater educability and plasticity of mental traits under the influence of the uniquely social environments to which man has been continuously exposed.

The effect of natural selection in man has probably been to render genotypic differences in personality traits, as between individuals and particularly as between races, relatively unimportant compared to their phenotypic plasticity. Instead of having his responses genetically fixed as in other animal species, man is a species that invents its own responses, and it is out of this unique ability to invent, to improvise, his responses that his cultures are born.

The Problems of Gerontology

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WITHIN RECENT DECADES THE specialty of pediatrics has developed out of the general field of medicine, and with this specialization progress in promotion of the welfare of children has been largely accelerated. It is rather remarkable that until lately the opposite stretch of the life span has remained a largely neglected field of interest. There is abundant reason to believe that comparably focalized interest in the problems of aging will yield much of profit not only to the elderly themselves but also to society at large. All the various approaches to this problem are incorporated in the science of gerontology.

Generally speaking, the methodology of gerontological research amounts simply to contrasting the youthful and the aging organisms with respect to their various biological characteristics. By the introduction of this comparative feature, almost any research in any field of biology, from that of biochemistry to that of sociology, can be made, in effect, a research in gerontology. This is equally true whether the given research is addressed to description or to experimentation. An important aspect of investigative gerontology is therapeutic research. Thanks to the fact that large aggregations of elderly persons are available in different sorts of eleemosynary institutions, it is possible to set up this type of study with more adequate controls than are possible in many other sorts of therapeutic research.

At the *molecular level* of integration[1] many studies are needed. A few sorts of these may be particularized. One functionally important class of molecules is the amino acids. In view of the special influences of various of these on the processes of cell differentiation and maturation, significant correlations might be found between amino-acid metabolism and acceleration or retardation of the aging processes as well as the biological efficiency of the organism at any given age. Various other metabolically important molecules, such as cholesterol and folic acid, also demand consideration.

Much remains to be elucidated about the different internal secretions. The two major problems in this part of the field involve determination, at various ages, of the levels of production of the several hormones and the reactivity of the body to each. What is partly known regarding the influences of the gonadal, the thyroid, the adrenal, and the anterior pituitary hormones on maturation processes renders further studies along this line imperative. A chief methodological need is to bring to bear the latest advances in the field of physical chemistry in the hope of deriving technics for the quantitative appraisal of the titers of each of the hormones in the circulating blood. Until this is accomplished we shall have to continue to limp along, deriving such information as is possible from studies of urinary excretion of the hormones or their end metabolites. Generally speaking, the entire endocrinology of the senescent and senile periods is in need of further study.

An equally persuasive case can be made for a study of the different vitamins in relation to the aging processes and to the various organic functions in postmature individuals. A modicum of information is available indicating that anomalies of vitamin assimilation and metabolism are characteristic of the aged, but much more particularized knowledge of each of these controlling agents is needed in relation to both health and disease. The functional interrelations of the vitamins with each other and with the hormones demand further study.

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[1] For a recent discussion of the concepts of integrative evolution, see Novikoff (*3*). A discussion of the applicability of the concepts to a larger biological problem has been offered by the writer (*2*).

Perhaps more important than any of these other specialized molecules are the enzymes by which cellular chemistry is so largely regulated. Both the formation of, and reactions to, the hormones are seemingly matters largely of special enzyme metabolism. Presumably, the enzymes play an equally important role in vitamin metabolism. Underlying many of the pathological processes as they become visibly manifested in cells and organs are, no doubt, perturbations of enzyme factors in metabolism. Many years of searching investigation of the enzyme physiology and pathology of senescence are obviously needed.

A major aspect of all the above-mentioned problems is a determination of the extent to which the various anomalies and their consequences in form and function are reversible at the various age periods. A special facet of this problem is the therapeutic possibilities of these various agents for retardation or amelioration of senescence.

Turning to manifestations at the *cellular level*, we find that these are to a considerable extent obvious consequences of phenomenology at the molecular level. There are, however, important aspects of cell biology that cannot be studied in terms of immediate chemistry. In general, these include the form, size, structure, differentiation, and integrity of cells. It is at this level that much of the phenomenology of pathology as now visualized appears. The aspects of cellular pathology that are most obviously important to gerontology are neoplastic growths and degenerative changes in the various tissues. The need for the development of a more adequate functional cytology is evident. In various ways the microchemistry of the cells already lends itself to study, and other methods no doubt will appear as the resources of the newer physical chemistry are brought to bear. The recent work of Dempsey and his colleagues seems especially promising to this end. These latter approaches seem, on the whole, more promising for the elucidation of cellular physiology and pathology than does electron microscopy. The influences of imposed variations in hormone, vitamin, and enzyme factors on cytology—and especially functional cytology—offer scope for many investigations in this field.

At the *organ-function* level of emergence appear the architecture and the activities of the organs and organ systems, *as such*. Generally speaking, productive studies at this level require different concepts and technics than at the metabolic or cellular level. Most of the so-called "vital-function" tests pertain to this level, e.g. "gastric-acidity," "renal-function," or "liver-function" tests; and it is also at this level that the principles of homeostasis as elucidated by Cannon largely operate. Phenomena at this level make up a large part of the subject matter of geriatrics as now visualized. Numerous of the most obvious problems of gerontology consist of comparisons of elderly and younger individuals with respect to organ efficiency and of therapeutic measures to improve such efficiency. The problem of promoting longevity is customarily studied chiefly at this level, although studies at the molecular level might actually be more productive.

At the *simple behavioral level* we first have to deal with the "organism as a whole." At this level such manifestations as maze learning, breeding patterns, nest building, and various sorts of still more primitive behavior come to attention. This category of activities is a matter of much interest in comparative biology, but in the case of human beings the phenomenology can profitably be studied for the most part in connection with those of the next higher level, the psychological or ego-oriented.

At the *psychological level* appear those many biological manifestations in which the neopallium plays an important or dominant role and in which "reactions in consciousness" are the matters of central interest. Much of the existing knowledge of activities at this level is conceptualized in terms of ego function. Here we deal with that vast array of items that make up the subject matter of psychology and psychiatry as organized disciplines, and here many of the most important problems of gerontology arise. It is the operation of factors at this level that largely determines whether longevity promoted at lower levels is actually worth the while of the individual himself.

In this necessarily brief discussion adequate presentation of the psychology of senescence is impossible. The place of psychology in the total over-all problems of gerontology can, however, be indicated. Many of the older technics can still be utilized and, as newer technics appear, these too can be applied to the elucidation of the differential characteristics of the aging.

Obviously, the chief desiderata in the later years are a sense of physical well-being and feelings of interest and contentment. The possibilities of psychotherapy for the aging center largely in the last-mentioned item. Individual therapeutic efforts and organized projects addressed to individual psychological welfare are most productively based on a consideration of the fundamental human drives as these have been derived through the long course of evolution. The relative potencies of the drives can be appraised in accordance with their operational significance in promoting individual or group survival.

Throughout the evolutionary period superiority has been a necessity for survival. This necessity is represented subjectively by the sense of self-esteem. A primary requisite to individual contentment, then, is the preservation of a tolerable degree of self-esteem.

The need for a sense of security is likewise of obvious importance and can be dealt with to some degree at the psychological level—but the problems are rather more social and economic. A sense of insecurity is a chief cause of anxiety, which not only deprives the individual of contentment but likewise leads to numerous perturbations at the physiological level. Since these latter are often life shortening, a part of the actual problem of longevity lies at the psychological level. Anxiety, as such, can be controlled in a measure by psychotherapy. Some of the simpler means to this end have been discussed elsewhere (*1*).

As to other possibilities for research at this level, only one further hint will be offered. Most of the drives that have to be considered are those addressed to individual survival. The gregarious pattern of living which our ancestors evolved is implemented to a considerable extent by another set of drives—those addressed to group survival. A major factor here is the sense of group solidarity; at the individual conscious-emotional level, this "sense" may be designated as "empathy" (*2*). A lively degree of empathy is a requisite to inner health and hence to contentment.

The upper limit to which the processes of integrative evolution have carried our species is the *social level*, and it is at this level that some of the most important problems of gerontology are presented. Issues of large moment hang on the fact that the modal citizen is constantly becoming an older person. Many social and especially economic adjustments to that fact are increasingly demanding attention. Not only, of course, is the welfare of the aged involved but that of the younger groups as well. The need for the development of more adequate technics for research at the social level is obvious—indeed, our survival as a species is involved.

The central problems of gerontology at this level are those of adapting the aging individual to the changing society and of evolving social patterns in which the values of the older individuals can most adequately be utilized. The impressive work of Lawton in New York is showing with increasing clarity how studies at this level can yield much in the way of enhancing the contentment of the elderly. Perhaps equally important to this end are the studies of Ford and others on the possibilities of utilizing the older workmen in industry.

Belatedly, several specialized agencies are now in process of development for the promotion of gerontology. Geriatrics, having to do with diseases of the elderly, has its recently organized society and its journal, *Geriatrics*. Less than a year ago a broader approach was visualized in the organization of the Gerontological Society, Inc., and the founding of the *Journal of Gerontology*. This Society and its journal propose to deal with the problems of aging from all the relevant and significant points of view. It is expected to enlist the cooperation and support not only of physicians but of other serious students, such as biologists, physiologists, pathologists, psychologists, sociologists, economists, and administrators—in short, of all who are contributing actively to the solution of the problems of aging. During the first year of its existence the Gerontological Society has been engaged primarily in the building up of a strong and representative body of charter members. Information regarding this organization can be obtained from the secretary, Dr. Henry S. Simms, 630 West 168th Street, New York 32, New York. Applications for membership are welcome.

A still more recent development is the setting up of a Gerontology Study Section in the Research Grants Division of the National Institute of Health (*4*). Under the chairmanship of Dr. Henry S. Simms, Columbia University Medical Center, and the secretaryship of Dr. Nathan W. Shock, National Institute of Health, Bethesda, Maryland, this Section proposes to take an aggressive and constructive part in promoting progress in its field. The Federal law under which the Research Grants Division operates permits much freedom of action both to the Section and to cooperating investigators. Especially noteworthy are the thoughtful provisions that have been set up to insure freedom of action and responsibility of the immediate proponents. It is presumed that adequate funds will be available for the support of any sound projects that may be offered or devised by the Section itself. Another provision of major promise for advancement over the longer period is for generously-funded training fellowships. In short, at long last, the way is broadly opened for the support and encouragement of researches of any and all sorts for the welfare and social utilization of the aging members of society.

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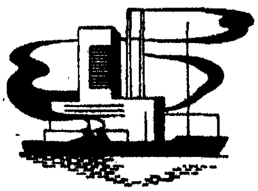

A Tax Credit Plan for Re-establishing Private Support of Pure Science

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THE HEAVY TAXES NOW LEVIED against incomes have virtually dried up private support for American science. Its revival need not, however, be contingent upon the return of that visionary day when the Federal budget will again approach its predepression size. Another and very simple means is at hand. Being flexible to a high degree, this means can be made sufficiently productive to carry the full load of pure science, or it can be operated in parallel with the appropriation of funds from the Federal Treasury.

By way of explanation of the plan, let us first note the inequalities of reckoning which the income tax law now accords to different income classes. Assuming that our goal is to complete a certain budgetary quota for pure science, each dollar entering the quota should be counted as of equal value, irrespective of its source. In other words, the dollar contributed voluntarily to science should count equally with the dollar processed by the tax collector. Under the present tax formulas, however, this is not the case. The person who voluntarily donates a \$1.00 finds his tax reduced not by \$1.00 but by an amount lying between the approximate limits of \$.19 and \$.85, depending upon whether he stands at the low or the high end of the income scale. As for a contributing corporation, its dollar counts for a maximum of \$.38. If science is hereafter to receive support partly from private donations and partly from the Federal Treasury (an arrangement that many advocates of Federal aid hope for), it seems definitely illogical that the only dollars to count at full value should be those taken, and later contributed, by the tax collector.

While recognizing that inconsistencies in the tax schedules are nothing new and are perhaps not overly embarrassing to tax authorities, I wish to emphasize, nonetheless, that the removal of these disparities might readily suffice to produce even greater support for science than any one dreams of asking from the Government. In short, the rectification which becomes logical, were Treasury funds to be drawn upon to participate jointly with private aid, might well result in making the Treasury funds unnecessary.

Let us now see how the plan might operate in the current year. The total income tax payments from individuals on incomes earned in 1946 is (in round figures) \$18,000,000,000. In the tax discussions now taking place in Congress, reductions in individual taxes ranging from 10 to 30 per cent are mentioned. If it is supposed that the amounts finally agreed upon average 15 per cent, then, using for 1947 the 1946 base of \$18,000,000,000, this would represent a reduction of \$2,700,000,000. This reduction is so large that a few per cent of it would equal any sum that has been mentioned as appropriate for additional aid to science, and when the contributions that may be expected from corporations are taken into account, the sum that would be needed from private donors becomes even a smaller quantity in comparison with the presumptive tax reduction.

The specific proposal, then, is that, from the shortly-to-be-established tax reduction, Congress channel approximately 2–3 per cent to science by the expedient of informing the taxpayer that he will get full tax credit for any contribution (up to, say, 5 per cent of his income) which he makes to approved scientific agencies. Many of these contributions, and especially those from corporations, would be made to the National Science Foundation if, as may reasonably be assumed, such a body is created. If any taxpayer does not elect to make such a contribution, he may expect the tax collector to demand an equal sum. As a matter of fact, adequate support may reasonably be expected to flow from the recipients of large incomes alone (*i.e.* from the group who are already accustomed to making systematic contributions) without drawing from the small-income groups, the mobilization of which might well require considerable time and effort.

Although here expressed in terms of a percentage of the pending tax reduction, the credit system is, of course, envisaged as applying year after year, the mechanism being the same whether or not a tax reduction for any year is in prospect. The allowable credit would be stated as a fraction of the taxpayer's net income (5 per cent, for example), and, while this fraction might be subject to modification from time to time, any change would be incidental to the operation of the plan. There might, however, be some advantage from the taxpayer's standpoint in launching the plan in a year when a tax reduction is in prospect. It might be mentioned that the plan has been discussed with tax experts and is believed to involve no hidden difficulties of administration.

But, it will be objected, the plan grants to pure science

This plan has been placed before Congress, but its details and the reasons for its proposal are not generally understood among scientists. The plan was referred to by F. B. Jewett in his recent statement before the House Committee on Foreign and Domestic Commerce.

the privilege of a special tax treatment which would not be accorded the many other forms of philanthropy. This is true; yet such a charge is even more to be leveled against the proposal to support science out of Federal funds. This represents the very pinnacle of partiality. No possible course of action could give science a more favored position, and if any charge of favoritism is to be brought, the plan of Treasury aid is clearly more liable than the plan for modifying the income tax formulas.

Moreover, the charge of partiality against the plan becomes even weaker if the tax credit is allowed to apply to donations to educational purposes generally. Expressing the basic doctrine that universal education is essential to our democratic way of life, governments, both state and federal, have traditionally encouraged and supported virtually all forms of education. In fact, any proposal to put greater stress upon higher education and research—the current appeal for a National Science Foundation being a case in point—can succeed only as it is supported upon a broad and effective base. At this very time, many of our leading universities are more in need of funds to defray current expenses than for more scholarships, fellowships, and research. It is therefore pertinent to point out that the tax credit plan here proposed is so flexible that it could be used, were Congress so minded, to create a broad-gauge and long-range program in aid of American scholarship in all its branches.

Everyone recognizes that many of the serious postwar problems looming up are not in the domain of the exact sciences at all, although many of them have had their birth in the social and political consequences of technology. As a nation, our success in the future depends increasingly upon broadening our understanding of such areas of learning as sociology, political science, economics, and psychology—call them sciences or not, as we choose. Congress can, if it will, shore up the entire foundations of American learning and scholarship and do so in a manner that will need little, if any, surveillance for a long time to come. Moreover, this can be done without enacting any novel legislation. It may be expected to occur spontaneously, once there is inaugurated the income tax credit that is deductible from the tax that is otherwise payable.

NEWS *and Notes*

The British Association for the Advancement of Science has invited Kirtley F. Mather, Harvard University, to deliver a lecture at its Dundee meeting (*Science*, May 16) under the exchange lectureship arrangement entered into by the AAAS and the BAAS in 1938. The Council of the BAAS has extended an invitation to Andrew C. Ivy, University of Illinois Medical School, Chicago, to be the guest of the Association at this meeting.

About People

H. A. Wilhelm, Department of Chemistry, Iowa State College, has been appointed assistant director of the Iowa State College Institute for Atomic Research. Ellis I. Fulmer, professor of chemistry at Iowa State, will join the staff of the Institute as research professor and assistant to the director.

C. C. Wylie, professor of astronomy, State University of Iowa, and secretary of Section D, AAAS, has been appointed director of the recently created Meteor Section of the Meteoritical Society.

Neal A. Weber, formerly associate professor of anatomy, University of North Dakota Medical School, has been appointed associate professor of zoology at Swarthmore College.

Henry S. Johnson, dean, College of Pharmacy, University of Connecticut, retires this month from his administrative duties but will continue on the staff as professor of chemistry. Dr. Johnson, who has been associated with the College since it was opened in 1925, is succeeded as dean by H. G. Hewitt, Department of Chemistry, University of Buffalo.

A. H. Compton, chancellor of Washington University, St. Louis, delivered the principal address at the dedication of the Iowa State College Institute for Atomic Research May 17.

Willard A. Kerr, assistant professor of industrial and social psychology, Tulane University, has been appointed associate professor of psychology and education, Illinois Institute of Technology, effective September 1.

Alfred L. Kroeber, formerly professor of anthropology, and director, Museum of Anthropology, University of California, Berkeley, has been appointed visiting lecturer on anthropology in the Department of Social Relations, Harvard University, for the academic year 1947–48.

Frank T. Gucker, Jr., professor of chemistry, Northwestern University, has been appointed professor of chemistry and chairman, Department of Chemistry, Indiana University, and will assume his duties there in September.

George Bachmann, professor emeritus of physiology, and chairman, Department of Physiology, School of Medicine, Emory University, for the past 37 years, will retire at the end of the present academic year.

H. P. Robertson, a member of the faculty of Princeton University since 1928, has been appointed professor of mathematical physics, California Institute of Technology, effective July 1.

J. Gordon Carlson, senior biologist at the National Institute of Health, Bethesda, Maryland, has been appointed professor and head of the Department of Zoology, University of Tennessee, Knoxville. He will assume his duties there on June 15.

Donald Sheehan, professor of anatomy and lately acting dean of the New York University College of Medicine, has been appointed general director of the Commonwealth Fund, succeeding Barry C. Smith, who will retire September 1.

Carl W. Blegen, professor of classical archaeology and fellow of the Graduate School of Arts and Sciences, University of Cincinnati, is en route to Greece to complete arrangements for the University's next excavation project at the site of the Palace of King Nestor at Pylos. Dr. Blegen, who directed the University's seven annual archaeological expeditions to the site of ancient Troy in the 1930's, also plans to go to Turkey to check the details for a final report of the Trojan excavations, now being prepared in book form under his direction.

E. C. Watson, professor of physics at California Institute of Technology, has been appointed chairman of the Division of Physics, Mathematics, and Electrical Engineering, a position formerly held by William V. Houston, now president of Rice Institute.

Byron B. Clark, associate professor of physiology and pharmacology at Albany Medical College, has been appointed professor of pharmacology at Tufts College Medical School and will assume his duties there on July 1.

Martin Kilpatrick, professor of chemistry at the University of Pennsylvania, has been appointed chairman of the Department of Chemistry at Illinois Institute of Technology, effective September 1. During the war, Dr. Kilpatrick served as assistant to the director of research on the atom bomb project at Columbia University and also as consultant and coordinator for the U. S. Navy Bureau of Ordnance.

Leon M. Pultz, professor of botany, and head, Department of Botany and Range Ecology, University of Arizona, has been appointed professor of horticulture and head, Department of Horticulture, effective July 1. His present position will be filled by Walter S. Phillips, associate professor of botany at the University.

W. Henry Hollinshead, professor of anatomy and one of the original members of the staff of the Duke University School of Medicine, has been appointed professor of anatomy at the Mayo Foundation and Graduate School of Medicine, University of Minnesota. As of July 1 he will organize and head a Department of Anatomy being established by the Mayo Clinic.

Edward K. Bender, recently assistant county agent in Montgomery County, Maryland, has been appointed to the Extension Staff of the University of Maryland as vegetable crop specialist in the Department of Horticulture. He previously taught agricultural courses for the U. S. Navy.

Andrew A. Marchetti, associate professor of obstetrics and gynecology, Cornell University Medical College, and attending obstetrician and gynecologist at the New York Hospital, has been appointed professor and head of the Department of Obstetrics and Gynecology, Georgetown University School of Medicine and Georgetown University Hospital.

Howard D. Lightbody, formerly chief of the Biochemical Division, Western Regional Laboratory, Albany, California, has been appointed chief of the Food Research and Development Division, Quartermaster Food and Container Institute, Chicago.

Visitors to U. S.

James A. D. Nash, of the Department of Scientific and Industrial Research, Wellington, New Zealand, has recently arrived in Washington, D. C., to succeed G. Maskill Smith as head of the New Zealand Scientific Liaison Office.

W. H. George, head of the Department of Physics, Chelsea Polytechnic Institute, London, is in this country until September 3. On his visit, which is sponsored by the Ministry of Education, he will study science teaching and research in American colleges and universities, with special reference to physics. Dr. George is available for lectures on the scientific method and will be glad to know of any work on the teaching of this subject. He may be reached in care of The British Information Services, 30 Rockefeller Plaza, New York 20, New York.

José María Perelló, professor of pharmacognosy, University of Madrid, and head, Division of Physiology, Institute of Pharmacognosy, is visiting the University of California, Berkeley, to observe techniques in plant nutrition and physiology and review literature in his fields of interest. He will visit other American institutions and those in several Hispanic-American countries before returning to Spain. Also visiting the University of California from the same University and Institute is Luis Recalde, who is studying the problems of genetics as related to pharmacognosy.

C. J. Gorter, professor of physics and co-director, Physical Institute, University of Leiden, and formerly Zeeman professor of physics, University of Amsterdam, will be a visiting lecturer at Harvard University for the 1947 summer term. He will conduct one course in advanced dynamics and one in relaxation phenomena. The latter will treat magnetic and dielectric absorption and dispersion in alternating fields, a subject in which Prof. Gorter has made outstanding contributions.

Corneille Heymans, professor of pharmacology, University of Ghent, has been visiting the University of Minnesota to work with Ernst Gellhorn, professor of neurophysiology, on a program of experimentation concerning the central nervous system, circulation, and respiration. On May 13 Dr. Heymans gave a special address at a meeting of the Minnesota Pathological Society on "The Role of Presso- and Chemoceptors in the Regulation of Respiration."

Grants and Awards

The New York Academy of Sciences announces that three prizes, offered by A. Cressy Morrison and to be known as the A. Cressy Morrison Prizes I, II, and III, are to be awarded in December 1947. Prize I, of $500, which is open to anyone, is offered for the paper judged by the Council of the Academy to be the most meritorious contribution on the subject of the source of solar and stellar energy. Prizes II and III, of $200 each, which are open only to members of the Academy and its affiliated societies, will be awarded for the two most acceptable papers in any field of science covered by the Academy or an affiliated society. Further details may be obtained from the Executive Secretary, New York Academy of Sciences, Central Park West at 79th Street, New York City. The closing date is October 15, 1947.

McGill University, Montreal, Canada, will receive a grant-in-aid from the Bristol-Myers Company to enable it to establish a Research Institute of Biophysics within the Department of Medicine of the McGill University Medical School, and to establish fellowships for study within the Research Institute. Work at the Institute, which is to be under the direction of Kenneth A. Evelyn, McGill University, will embrace laboratory and clinical investigations in the field of medical radioactivity and cardiovascular research.

Carl F. Cori, Washington University Medical School, St. Louis, is the recipient of the second intermediate Sugar Research Prize of $5,000, awarded annually by the National Science Fund of the National Academy of Sciences in recognition of the development of original knowledge about sugar. William C. Stadie, professor of research medicine, University of Pennsylvania, made the presentation in behalf of the National Science Fund. One of Dr. Cori's most significant contributions is the indication of the manner in which insulin influences the burning of sugar. Dr. Cori is also credited with notable discoveries about the metabolism of tumors, the disposition of sugar in the body, and the role of organophosphates and hormones on metabolism. His investigations also led to the discovery of the enzymes, phosphorylase and hexokinase. The award was presented at the annual dinner of the Foundation held at the Yale Club, New York, on April 28.

Matthew Luckiesh, director, Lighting Research Laboratory, General Electric Corporation, will be the recipient of the I.E.S. Gold Medal, to be presented at the Illuminating Engineering Society National Technical Conference on September 15–19 in New Orleans. The medal is given annually by the Illuminating Engineering Society "for meritorious achievement which has conspicuously furthered the profession, art, and knowledge of illuminating engineering."

Otto Stuhlman, Jr., professor of physics, University of North Carolina, received the Poteat Award at the 64th annual meeting of the North Carolina Academy of Science, held at Wake Forest College May 9–10, in recognition of his biophysical paper, "A Dynamical Analysis of the Movements of the Lobes of the Venus' Flytrap."

Presidential Medals for Merit have been presented to four prominent scientists for outstanding contributions to the Navy's war effort in the development and application of new techniques, weapons, and devices used in World War II. Those receiving the awards were: John Torrence Tate, chairman of research and professor of physics, University of Minnesota; Frederick Vinton Hunt, chairman of the Department of Engineering Sciences, Harvard University; Gaylord P. Harnwell, chairman of the Department of Physics and director of the Randal Morgan Laboratory of Physics, University of Pennsylvania; and William Vermillion Houston, president of Rice Institute. The medals were presented by Assistant Secretary of the Navy W. John Kenney on May 5.

Fellowships

The Johns Hopkins University has announced the establishment by the International Nickel Company of a graduate fellowship of $1,900 in the School of Engineering. This fellowship is open to graduate students in engineering and may be held for two consecutive years, during which the recipient must devote himself to study and research dealing with developments in the properties and applications of nickel, copper, platinum, or alloys containing any of these metals. It is anticipated that the fellowship will be most applicable to the work of students in the fields of mechanical, chemical, or electrical engineering. Applications should be sent to the Dean of Engineering, The Johns Hopkins University, Baltimore 18, Maryland, by July 1, 1947.

Summer Programs

The University of Michigan College of Engineering offers a Smyposium on Fluid Mechanics and several advanced courses in engineering during its summer session, June 23–August 16. The course, Engineering Mechanics 141, will be conducted largely by Hunter Rouse, director, Institute of Hydraulic Research, State University of Iowa, and Sydney Goldstein, University of Manchester, England. Others conducting lectures and seminars during the summer session will include: Boris A. Bakhmeteff, professor of civil engineering, Columbia University; Hugh L. Dryden, assistant director, National Bureau of Standards; J. E. Warnock or D. J. Hebert, Bureau of Reclamation; L. G. Straub, professor of civil engineering and director, St. Anthony Falls Laboratory, University of Minnesota; John Stack, chief, Compressibility Division, NACA Laboratory, Langley Field; V. L. Streeter, research professor in mechanics, Illinois Institute of Technology; M. J. Thompson, professor and chairman, Department of Aeronautical Engineering, University of Texas; Th. von Kármán, California Institute of Technology; and various members of the University faculty. For information concerning the courses or requirements for graduate credit, correspondence should be addressed to Prof. L. A. Hopkins, Director, Summer Session, University of Michigan, Ann Arbor, Michigan.

Meetings

A symposium on "Recent Biophysical Advances in Physiology" is to be held on June 11 under the auspices of the Medical Division, Army Chemical Center, Edgewood, Maryland. The morning session will include the following papers: "New Techniques for Micro Gas Analysis," Per F. Scholander, Swarthmore College; "Respiration in Diving Animals," Laurence Irving, Swarthmore College; "Biophysical Studies of Acceleration," E. J. Baldes, Mayo Clinic, Rochester, Minnesota; and "Instrumentation in Bioclimatological Research," Victor Guillemin, Aero Medical Laboratory, Wright Field, Dayton, Ohio. The following papers will be included in the afternoon session: "Kinetics of Reaction of Oxygen and Carbon Monoxide With Hemoglobin *in Vivo and in Vitro*," F. J. W. Roughton, Cambridge, England; "Measurement and Significance of Oxygen Consumption in the Nervous System," Detlev W. Bronk, Johnson Foundation, University of Pennsylvania; and "Applications of Electrical Excitation," H. A. Blair, University of Rochester.

Interested physiologists are welcome to attend. Inquiries regarding the symposium may be addressed to Col. John R. Wood, Chief, Medical Division, or to David B. Dill, Scientific Director.

The 10th National Organic Chemistry Symposium of the American Chemical Society will be held in Boston June 12–14 under the joint sponsorship of the Society's Division of Organic Chemistry and Northeastern Section.

The technical sessions, under the chairmanship of Arthur C. Cope, of Massachusetts Institute of Technology, will feature papers on: "Naphthoquinones," by Louis F. Fieser, Harvard University; "Influence of Substituents on Polarity in the Benzene Ring," Charles

C. Prince, University of Notre Dame; "The Behavior of Organic Compounds in Sulfuric Acid Solution," Melvin S. Newman, Ohio State University; "Recent Studies in Steric Effects," Paul D. Bartlett, Harvard University; "Alkylation by Amines and Amine Derivatives," H. R. Snyder, University of Illinois; "Chemistry of the Sphingolipids," Herbert E. Carter, University of Illinois; "Synthesis of Unsaturated and Bridged Eight-membered Ring Compounds," Dr. Cope; "Synthesis of Some Compounds Related to the Female Sex Hormones," A. L. Wilds, University of Wisconsin; "Some Sulfur-containing Amines," Chester M. Suter, Sterling-Winthrop Research Institute, Rensselaer, New York; "The Stobbe Condensation and the Synthesis of Fused Ring System," William S. Johnson, University of Wisconsin; "The Chemistry of Cyclopentadiene Polymers and Adducts," Herman A. Bruson, Resinous Products & Chemical Company, Philadelphia; and "The Stereochemistry of Five- and Six-membered Rings," Richard T. Arnold, University of Minnesota.

James B. Conant, honorary chairman of the symposium, will speak at the symposium dinner on June 13 at the Hotel Statler, headquarters for the meeting.

The University Conference on Corrosion and Metal Protection, to open at the Museum of Science and Industry, Chicago, on June 11 for a three-day session, will feature technical papers of a quantitative and research character which emphasize the science background of corrosion rather than the art of corrosion testing and practice. Henry T. Heald, president, Illinois Institute of Technology, will present the opening address, which will be followed by the presentation of papers. Those participating are: Mars G. Fontana, Ohio State University; Norman Hackerman, University of Texas; G. A. Marsh and R. D. Misch, Illinois Institute of Technology; R. L. Starkey, New Jersey Agricultural Experiment Station; C. V. King, New York University; Thomas C. Poulter, Armour Research Foundation; C. F. Prutton and David Turnbull, Case School of Applied Science and General Electric Company, respectively; H. A. Miley, Air Technical Service Command, Watson Laboratories; James T. Waber, Illinois Institute of Technology; H. H. Uhlig, Massachusetts Institute of Technology; Michael A. Streicher, Lehigh University; Charles A. Mann, University of Minnesota; A. L. Ferguson, University of Michigan; and W. H. Zinn, Argonne National Laboratory.

The Conference is being sponsored by Carnegie Institute of Technology, Illinois Institute of Technology, Lehigh University, Massachusetts Institute of Technology, Ohio State University, and the Universities of Chicago, Colorado, Minnesota, and Texas. Those interested in the fundamental aspects of corrosion are invited to attend and to participate in the discussion.

Elections

The Southwestern Division, AAAS, at meetings held with the Colorado-Wyoming Academy of Science May 1-3 at Colorado College, elected Frank E. E. Germann executive secretary, and F. H. Douglas president. H. B. Van Valkenburgh was elected president of the Academy.

The Royal Society, London, at a meeting held on May 1, elected the following foreign members: Elie Joseph Cartan, professor of geometry, University of Paris; Paul Karrer, professor of chemistry, University of Zurich, and 1937 Nobel Prize winner; Harold Clayton Urey, professor of chemistry and director of the Institute for Nuclear Studies, University of Chicago, and 1934 Nobel Prize winner; and Øjvind Winge, Carlsberg Laboratory, Copenhagen.

The American Philosophical Society has elected the following officers for the coming year: Thomas S. Gates, president; Ross G. Harrison, Alfred N. Richards, and St. George L. Sioussat, vice-presidents; Ernest M. Patterson and Jacob R. Schramm, secretaries; Francis R. Packard, curator; Joel Stebbins (Class I), Edmund W. Sinnott (Class II), Edwin B. Wilson (Class III), and Howard M. Jones (Class IV), councilors to serve for three years. Residents of the United States elected to membership in Class I (Mathematical and Physical Sciences) include Hans Albrecht Bethe, William Albert Noyes, Jr., George Braxton Pegram, Henry DeWolf Smyth, and Hassler Whitney; Class II (Geological and Biological Sciences), Carl F. Cori, Conrad A. Elvehjem, Hermann J. Muller, William Christopher Stadie, and Edward Chace Tolman; Class III (Social Sciences), Arthur F. Burns, Sydney B. Fay, Walter Lippmann, and Robert Redfield; and Class IV (Humanities), Otto Neugebauer, Reinhold Niebuhr, Paul J. Sachs, and Stith Thompson. Foreign members elected to Class III were Henry Clay, Oxford, England, and Luigi Einaudi, Turin, Italy; to Class IV, Sir William David Ross, Oxford, England; William W. Tarn, Inverness, Scotland; and Lionello Venturi, Rome, Italy.

The Ohio Academy of Science, at its 56th annual meeting, held at Marietta College May 1-3, elected the following officers for the coming year: A. W. Lindsey, Denison University, president; W. M. Tidd, Ohio State University, treasurer; and Rush Elliott, Ohio University, secretary.

The retiring president, H. H. M. Bowman, of the University of Toledo, addressed the meeting on the subject, "Antibiosis." The 1948 meeting of the Academy will be held at the University of Toledo May 6-8.

NRC News

The Committee on Atomic Casualties held its second meeting in Washington, D. C., on May 1. This Committee, which was organized in compliance with a directive issued by President Truman in November 1946, will carry forward a continuing study of the biological and medical effects of atomic radiation on man. Under the Presidential Directive, the NRC, through the Division of Medical Sciences, was authorized to enlist the aid of government agencies and personnel and such civilian agencies and personnel as might be needed to carry out a long-term study of the Japanese casualties. Organizational and financial matters relative to the study were discussed by the Committee at its last meeting, and plans were made to launch investigations at the earliest possible time. Tentative plans call for the establishment of a central office in Washington and one or more field offices in Japan. The first group of investigators will probably be sent to Japan during the summer. The activities of the Committee will be carefully correlated with the responsibilities of the Atomic Energy Commission, which is expected to provide financial support for the Committee's work.

The Committee proposes to undertake studies on keloid formation resulting from exposure to atomic radiation, genetic effects of atomic radiation, the effect of radiation on the physical growth and development of children, and other clinical and pathological conditions observed since the bombings.

Thomas Rivers is chairman of the Committee, and the following are members: George W. Beadle, Detlev W. Bronk, Austin M. Brues, C. P. Rhoads, Shields Warren, Stafford L. Warren, George H. Whipple, and Raymond E. Zirkle. In addition to the members, medical officers of the Army, Navy, Public Health Service, and Veterans Administration and members of the Division of Medical Sciences are actively participating in the work.

It is noteworthy that the Committee favors the adoption of a liberal policy with respect to the publication of data on the medical and biological effects of atomic radiation and that the Atomic Energy Commission hopes to release as much information as possible on these aspects of radiation.

Recent Deaths

Sir Thomas Henry Holland, 78, retired principal and vice-chancellor, Edinburgh University, and a leading geologist and mineralogist, died May 17. Sir Thomas was formerly director of the Geological Survey of India, professor of geology and mineralogy, Manchester University, and rector, Imperial College of Science and Technology, South Kensington, England.

T. R. Agg, 69, dean emeritus, Division of Engineering, and former director, Engineering Experiment Station, Iowa State College, died May 7 at Mary Greeley Hospital, Ames, Iowa, where he had been confined since March 5.

Edward R. Baldwin, 82, honorary president of Trudeau Sanatorium, Saranac Lake, New York, and a noted authority on tuberculosis, died May 6 at his home at Saranac Lake.

William H. Ross, 71, retired senior chemist, Division of Soil and Fertilizer Investigations, Bureau of Plant Industry, U. S. Department of Agriculture, and assistant editor and abstractor of *Chemical Abstracts* since 1907, died May 16 at Washington Sanitarium, Washington, D. C.

P. A. Taverner, 71, former chief, Division of Ornithology, National Museum of Canada, died May 9 at his home in Ottawa, Canada.

Sir Frederick G. Hopkins, 86, Sir William Dunn professor of biochemistry, Cambridge University, England, died May 16. Sir Frederick, a Nobel Prize winner, was widely known for his vitamin researches.

Milo Hellman, 75, professor of dentistry, Columbia University School of Dental and Oral Surgery, and research associate in physical anthropology, American Museum of Natural History, died May 11 at St. Joseph's Hospital, Far Rockaway, New York, following a cerebral hemorrhage.

G. A. Maney, 58, professor of structural engineering and administrative chairman, Northwestern University School of Engineering, died May 10 at Evanston Hospital, Evanston, Illinois.

Human Relations, a new quarterly journal designed to supplement more specialized journals and to integrate the social sciences, has been organized for publication of comparative studies of the various social sciences at an international level. It will be edited by two committees drawn from the staffs of the Tavistock Institute of Human Relations, London, England, and the Research Center for Group Dynamics, Massachusetts Institute of Technology. The two editorial committees will be assisted by functional advisory editorial boards in Great Britain and North America, whose members represent many different social science disciplines.

Correspondence about policy, contributions, and subscriptions should be addressed to: *Human Relations*, Research Center for Group Dynamics, Massachusetts Institute of Technology, Cambridge 39, Massachusetts.

"Basic Graphical Symbols for Electric Apparatus," a new standard covering symbols used in drawings employed in wide sectors of the electrical field, is now ready for distribution, according to an announcement by P. G. Agnew, vice-president, American Standards Association. The standard, sponsored by the American Institute of Electrical Engineers and the American Society of Mechanical Engineers, supplements one developed in 1944. The symbols covering the power, electrical control, and communications fields, previously available in separate standards, may now be built up from the master symbol code.

Selective lists of technical reports and documents, *containing only the* most important materials in 13 specialized industrial fields available from the Office of Technical Services, Department of Commerce, have been prepared by the Office. The lists cover the following fields: plastics; vibrators, tampers, pneumatic tools, and drills; jet engines; psychology; infrared; ceramics; magnetic tape machines (magnetophone); adhesives; paper; deterioration; guided missiles; iron ores; and forestry and wood products. Each of the lists cites author, title, price, and reference number of the reports included.

Requests for copies should be addressed to: Reference Service, Office of Technical Services, Department of Commerce, Washington 25, D. C.

The National Registry of Rare Chemicals, Armour Research Foundation, 35 West 33rd Street, Chicago 16, Illinois, indicates that the following chemicals are wanted: trihexylamine, pyrithiamin, naphthazines, ergothioneine, thiolhistidine, kynurenine, dipeptidase, nucleosidase, 2-methoxy-4-ethylphenol, porphyrexide, porphyrindine, indican, carnosine, geranium powder, sumbul, phytic acid, synthaverin, octaverin, quercimeritrin, and m-dimethylaminophenol. Communications regarding these should be sent to the Registry at the above address.

Make Plans for—

Pacific Division, AAAS, 28th annual meeting, June 16–21, San Diego, California.

American Society of Mechanical Engineers, semiannual meeting, June 16–19, Chicago, Illinois.

Meteoritical Society, 10th meeting, June 18–19, San Diego, California.

American Society for Engineering Education, 55th annual meeting, June 18–21, University of Minnesota, Minneapolis.

Guidance Conference on the Measurement of Student Adjustment and Achievement, June 26–27, Ann Arbor, Michigan.

COMMENTS *by Readers*

Invitations to the 6th International Congress of Experimental Cytology to be held at Stockholm in 1947 carry the notice that it will not be open to German and Japanese scientists.

Those German and Japanese scientists that may have been accused of criminal actions in the past have been subjected to the legal procedures instituted by the allied nations in the occupied countries. Those that have been found guilty are subject to punishment like any other criminals and it is obvious that such men will not be able to attend the Congress.

We protest that the exclusion of scientists merely on the basis of their nationality is contrary to one of the fundamental tenets of the scientific creed. It belies the very name of the Congress and controverts its aims.

It is hoped that this tragic mistake, so similar to many that were made by scientists after the first world war, will not be allowed to stand. We beg that the restriction be lifted at once. (Th. Dobzhansky, Selig Hecht, Franz Schrader, and G. G. Simpson, *Columbia University*.)

The holding of international conferences this year has agitated the question regarding the participation of scientists from the former Axis countries, particularly Germany. Scientists in the past generally have been able to remain aloof from the psychology of enmity and war. A change came with Hitlerism. Today, our hesitation at accepting Germans to our conferences emanates not from the effects of actual combat but from the deeds which were performed by the German Government for years before the war and which attained their vilest proportions during the war. Every German who survived without protest against the regime he lived under must accept responsibility, be it of a lesser or greater degree, for the terrible fact that our present-day civilization has witnessed the official enactment of bestiality in a country we had learned to respect as enlightened.

I understand that some Germans are being invited to attend the conferences, the selection being limited to those who underwent physical suffering because of the stand they took against Naziism. Doubtless many endured mental suffering. We are sorry for them. We regret that there must be some who suffered persecution but, because of physical limitations of the several committees, are not on invited lists. We trust that, in time, the elimination of the perpetrators of Naziism and the delusions of the Nazi doctrine will gradually bring the German people back to a state of mind which will permit them to be respected again by the rest of the world.

Anyone approving of the decision taken by the International Congress of Experimental Cytology being held in Stockholm this summer, is invited to send a letter of confidence to the Congress for the stand which it has taken. (Robert Chambers, *New York University*.)

In the issue of April 4 Sally Hughes-Schrader protests against the exclusion of "German and Japanese *colleagues*" from international scientific congresses "on such *nonscientific ground* as nationality" (italics mine)....No *international* congress should admit the subjects of a nation that discriminated against the Nobel Prize, the highest known international award, because of its international character; of a nation that denies Hughes-Schrader's sentence that "science transcends considerations of nationality, as of race, color, and creed." No *scientific* congress should admit the subjects of a nation that falsified scientific facts, and called murder scientific investigation ... if German or Japanese subjects beg to be admitted to international meetings, may they be given the opportunity to prove that they disapprove *in public* of the Nazi behavior, and those who did so will be welcomed as men and scientists. The participation of other German or Japanese individuals will do good neither to science nor to humanity. (F. L. Hahn, *Apart. Post. 9622, Mexico, D. F.*)

The processes of evolution have required very long periods of time. A renewed impression of their near infinitude has been received from reading a discussion of the dispersal of faunas over land bridges. Those bridges were available during only fractions of evolutionary time and certainly were ecologically restricted in contrast to the continents connected. As animals cannot migrate for long distances over territory lacking their ecological requirements, the land bridges cannot be regarded as having been highways suitable for all to travel throughout their existence.

Another great retarding factor, which apparently has not been taken into consideration, is the highly sedentary nature of animal populations. As a rule, they remain on the ancestral range. The movements of individuals are limited, many passing their entire lives in an area of a few acres or less. With attachment to the home range so dominant, it is evident that animal populations, as a whole, could not move, or even be forced to move, at more than a glacial rate. Eons, no less, would be required for far-flung migrations of fauna.

True, there is also a dispersive factor; barriers permitting, animals do extend their ranges. But along with revelation by modern studies of the essential stability of populations, it has also been shown that animals leaving the home range suffer very high mortality. The young, among which centrifugal wandering is often evident, suffer a high proportion of the entire mortality of their species. Although some of them succeed in establishing themselves, usually in vacancies in the hereditary domain, this occurrence does not controvert the impression that the occupation of new territory is normally a very gradual process and, therefore, that extensive transfer of faunas by land bridges must have been an infinitely slow process. (W. L. McAtee, *5750 Ellis Avenue, Chicago, Illinois*.)

TECHNICAL PAPERS

Variations in the Normal Electroencephalogram During a Five-Year Period

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and *University of Cincinnati College of Medicine*

In the course of a variety of experimental studies during the past five years numerous electroencephalograms were obtained on three individuals who served as subjects. During this time these subjects were exposed to high altitude, decompression sickness, vasodepressor syncope, abdominal distension, anoxia, hypoglycemia, acapnia, fatigue, alkalosis from ingestion of large quantities of sodium bicarbonate, alcohol, and toxic doses of atabrin. Reversible changes were produced by many of these procedures. Two subjects during this period had several episodes of migraine with scintillating scotomata, during which focal slowing in the occipital region occurred. A large number of control records were obtained before and after recovery from these experiences. This mass of data on three individuals offers a good opportunity to study the variability of the electroencephalogram in the same individual over a five-year span.

Methods

A Grass three-channel electroencephalograph was used, and bipolar fronto-occipital tracings were obtained. Five to 10 minutes of record were obtained on each occasion. The records were analyzed by the technique already described in earlier publications (*2*), a frequency spectrum and mean frequency being derived for each record.

The subjects were all males, aged 29, 33, and 36, respectively, at the time of the first observations. The level of sugar in antecubital vein blood was measured at the time of each electroencephalogram, and in about one-third of the experiments rectal temperature was also recorded.

Results

There was no change in the gross appearance of the control electroencephalograms of any individual during the five-year period. No variation in regularity and no unusual wave forms or frequencies appeared. The amount of uncountable low-voltage fast activity ranged between 0 and 5 per cent. The changes produced by the experimental procedures noted above and during the scotomata of migraine were apparently completely reversible.

The spread of mean frequencies over the five-year period for each individual was as follows (Fig. 1): Subject A, 8.8–9.6 cycles/second (39 observations); Subject B, 8.3–9.3 cycles/second (32 observations); Subject C, 8.8–9.3 cycles/second (25 observations). Subject B showed some suggestion of an increase in frequency with successive years, but such a trend was not apparent in the records of the other subjects.

Blood sugar values varied as follows: A, 80–119 mg./100 cc.; B, 80–137 mg./100 cc.; C, 75–126 mg./100 cc. There was no consistent correlation between the daily fluctuations in mean frequency and in blood sugars.

Rectal temperatures ranged from 98° to 99.8° F. among the three subjects at different times, and there was no correlation between body temperatures and the small daily fluctuations in mean frequency.

Discussion

These results indicate that at least among three normal males in the fourth decade with very regular EEG's there was remarkably little change in mean frequency over a five-year period. We hesitate to attach any significance to the apparent slight increase in frequency in one subject. These findings are particularly noteworthy when one considers the variety of experimental conditions affecting the electroencephalogram to which these individuals were subjected.

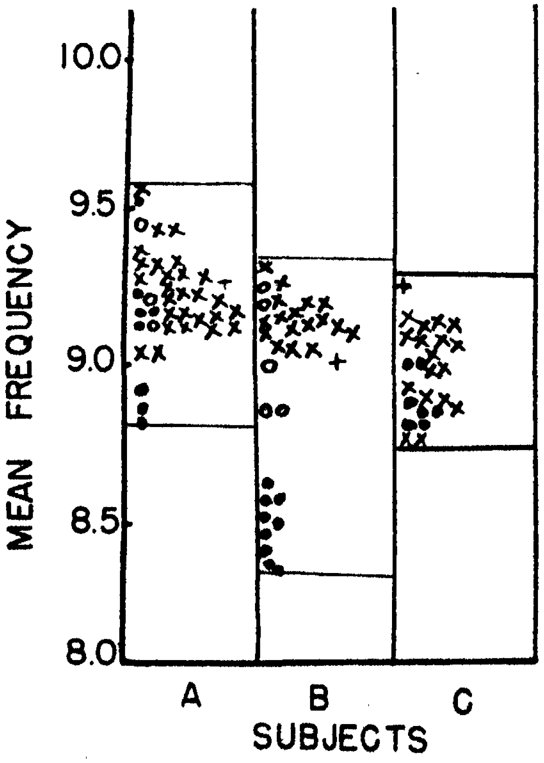

Fig. 1. 1942-●; 1943-O; 1944-X; 1946-+.

The stability of the EEG for the same individual is well known, but few quantitative and long-term observations are available. Davis and Davis (*1*) recorded EEG's of a number of subjects over four years and found no change in the gross appearance of the records. Loomis, Harvey, and Hobart (*4*) found the range of 16 mean alpha-frequency determinations in one subject over an eight-month period to be about 1 cycle. Jasper and Andrews (*3*) report a variation of only 1–2 per cent between measurements made on six normal individuals over a period of 6–18 months. Rubin (*5*), whose method of calculating mean alpha frequency corresponds closely to ours, found a variation of less than 1 cycle/second in the mean alpha frequency of a number of normal subjects and schizophrenics observed over periods up to four months. Thus, our results confirm and extend earlier observations.

The failure to find any correlation between the mean frequency and blood sugar level is of some interest, since we had previously reported variations in mean frequency with changes in blood sugar (*2*). However, in those studies the change was produced by the intravenous injection of sugar or insulin and was rapid. Evidently, at any given frequency level rapid changes in blood sugar will produce shifts in frequency, but the day-to-day variations in mean frequency must be accounted for on some other, as yet unknown, basis. This does not appear to be body temperature.

These results also give some indication of the reliability of this method of frequency analysis of the electroencephalogram. For clinical purposes, changes in mean frequency of greater than 1 cycle/second may be considered significant.

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Ordovician Chazyan Classification in Vermont

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Middle Ordovician limestones of west-central Vermont have been described and mapped by Cady (*1*), who included the Crown Point, Beldens, and Middlebury formations in the Chazy "group." Inasmuch as the first-named formation is structurally separated from the Crown Point limestone of the type locality and other outcrops in New York and is succeeded by the Beldens formation rather than by the Valcour limestone, it is proposed that the "Crown Point" formation east of the Champlain thrust in west-central Vermont be designated the Burchards limestone, named from a stream that enters the Lemon Fair River three miles west of the type locality in the belt of outcrop between Cornwall village and The Ledges, Addison County; the formation consists of about 150 feet of somewhat magnesian limestone that has a species of *Maclurites*. The Burchards and succeeding Beldens limestones and dolomites comprise a lithologic sequence that contrasts with the succeeding thinner-bedded Middlebury limestone. This sequence of Burchards and Beldens is designated the Chipman group from Chipman Hill, which lies in the belt of outcrop north of Middlebury village.

The "Chazy" rocks of northern Lake Champlain have been studied by Kay, who has described the Carman quartzite and Youngman formation of northwestern Vermont and southeastern Quebec as succeeding the Beldens in the Highgate Springs slice (*3*). The type Carman consists of about 120 feet of quartz sandstone. The Youngman, more than 300 feet of argillaceous, thin-bedded limestone grading up into dark slate having dense limestone lenses, has *Lonchodomas halli* (Billings) persisting, *Christiania* sp. common in basal beds, *Maclurites* sp. present higher, and *Rostricellula* sp. near the top; the section is somewhat incomplete in the type exposure because of a thrust fault. Kay believes it probable that the Carman quartzite is essentially equivalent to the quartzite in the lower Day Point formation that, with the succeeding Crown Point and Valcour, is the Chazy sequence in New York. It is proposed that the Carman and Youngman formations comprise the Maquam group, named from Maquam Bay, six miles south of the type sections at Highgate Springs, Vermont.

Inasmuch as all these sequences have been called Chazy for nearly a century or longer, it is recommended that the Chazyan series consist of the Chipman and Maquam groups, as well as the Chazy limestones of eastern New York. This use of Chazy is considered to have priority over the Chazyan of Grabau, which added the Black River group (*2*), and of Ulrich, which was for a composite of widely scattered stratigraphic units (*4*).

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A Study of the Inner Bark and Cambial Zone of Black Spruce (*Picea mariana* B.S.P.)[1]

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The inner bark and cambial zone of a tree contain living cells that are active in its life processes and growth. These cells take part in the conversion of sugars and other compounds, synthesized elsewhere, into wood and bark. A study of the composition of the living areas of the tree should help greatly in understanding the genesis of materials present in mature woods. Hitherto, relatively few investigations of this type have been undertaken, and, to the best of our knowledge, these have been limited to European woods (*1*). With this in mind, a study of the inner bark and cambial zones of freshly cut trees was begun during the summer of 1946.

Six layers were separated from a black spruce log, approximately 65 years old, which was cut on June 3, 1946. These layers were: (1) the outer bark, (2) the inner bark, (3) the cambial zone, (4) the young sapwood, (5) the sapwood, and

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[1] This investigation was suggested by Harry F. Lewis, of The Institute of Paper Chemistry. Acknowledgment is also made to the following staff members of the Institute: I. H. Isenberg, M. A. Buchanan, L. E. Wise, and P. F. Cundy. The authors express their appreciation to Robert Buxton and Mrs. Evelyn K. Ratliff, who made many chemical analyses of products isolated during the investigation.

(6) the heartwood. The cambial zone occurs as a slightly viscous layer on the inner surface of the bark and on the outer surface of the freshly peeled log.

After analysis of small samples of these layers, the results of which are shown in Table 1, larger portions were extracted with hot benzene, alcohol, and water. The inner bark was converted into holocellulose (*4*), which was successively extracted with a 3 per cent solution of ammonium hydroxide and a 5 per cent solution of potassium hydroxide. The various extracts have been analyzed. Although the work is far from complete, a brief report can now be made of the preliminary conclusions that were reached, and certain suggestive hypotheses may be formulated.

TABLE 1

ANALYSES OF FRACTIONS OF BLACK SPRUCE

(On the oven-dry basis)

	Outer bark	Inner bark	Cambial zone	Young sapwood	Sapwood	Heartwood
Ash, %	1.20	3.18	3.57	0.37	0.30	0.28
Nitrogen (Kjeldahl), %	0.32	0.60	1.09	0.26	0.05	0.06
"Protein" (N × 6.4), %	2.05	3.84	7.06	1.66	0.32	0.38
Pentosans, %	11.80	12.03	6.30	8.12	12.05	12.45
Uronic anhydride (CO_2 × 4), %	8.56	10.00	4.60	3.80	3.72	3.92
Lignin (Klason method) in:						
Unextracted material, %	33.9	6.6	1.83	24.9	26.3	26.1
Extractive-free material, %		9.00	6.03			
Methoxyl, %	4.00	2.19	0.72	4.73	4.89	4.75
Tannin (A.O.A.C. method), %	1.9	7.6	Neg.	Neg.	Neg.	Neg.
Starch test (iodine color)	Neg.	Pos.	Neg.	Neg.	Neg.	Neg.

The percentages of "protein" (calculated from Kjeldahl nitrogen) vary in the different layers from 0.3 in the mature wood through 1.65 in the very young sapwood and from 3.85 in the inner bark to 7 in the cambial zone. Although the layers were not separated completely, the higher percentages of "protein" in the inner bark and cambial zone presumably are due to the living material in these layers which contains the protoplasm of the tree. The amount of "protein" in the alcohol-insoluble part of the cambial zone was 19.2 per cent.

Crystalline sucrose to the extent of 33 per cent (on a dry basis) was obtained from the cambial zone. Sucrose was also found in considerable amount in the inner bark. Large amounts of alcohol-soluble sugar sirups from these two zones are yet to be studied.

The cambial zone was low in pentosans, lignin, and methoxyl. These materials are not characteristic of very young tissues but are often found in large amounts in older tissues. They were present in large amounts in the outer bark, sapwood, and heartwood. Possibly they originate in the cambial zone as metabolic products which are then laid down permanently in mature wood. Tannin was found only in the outer and inner bark of this wood.

The benzene extract of both the inner bark and the cambial zone contained a white solid, which may possibly be a glycoside, and a yellowish oil. The solid, which was difficult to separate from starch, did not dissolve in the benzene but was present in finely divided form in the solvent. It amounted to 0.5 per cent of the inner bark. This material gives intense colors with alkali and with methanolic HCl. The oil, which amounted to approximately 4 per cent of the inner bark, probably is similar to the material isolated by Wise and Moore (*3*) from black spruce wood. Fatty materials are known to originate during metabolism of sugars; it is possible that extractives, such as those reported by Wise and Moore, are formed in the living zone and transported later to the wood.

Pectic materials occur in rather large amounts in the inner bark of black spruce, where they are mixed with starch. These were isolated by successive extraction with hot water, very dilute hydrochloric acid, and 3 per cent ammonium hydroxide, and by precipitation as insoluble calcium pectate. They were also isolated from the holocellulose of the inner bark. An insoluble calcium pectate that gave 63.0 per cent uronic anhydride (as measured by evolution of CO_2) was isolated and converted to a pectic acid giving 75.4 per cent uronic anhydride. Because of their presence in greatest amounts in young tissues, it is probable that these materials are laid down during the early stages of cell-wall formation in wood.

Hemicelluloses were isolated by successively extracting the holocellulose of the inner bark with 5 per cent solutions of ammonium hydroxide and potassium hydroxide. For comparison, a hemicellulose was isolated by extracting the holocellulose of sapwood with 5 per cent potassium hydroxide. The chief difference noted between that from the inner bark and that from the sapwood is a much smaller percentage of methoxyl and pentosans in the former than in the latter. This suggests that the hemicelluloses in the inner bark are in the process of formation, whereas those in the sapwood are fully formed. In general, hemicelluloses in mature wood contain one ether-linked methoxyl group for each uronic acid group (*2*). Those from the living part of the tree, such as the inner bark, appear to have less than one methoxyl for each uronic acid group. It is possible that, as methoxyl groups are produced in the metabolic processes of the living zone, they are removed from the system by combination with uronic acids. In this connection it has been found that Klason lignin from the bark has a lower methoxyl content than that from mature wood.

This difference would be explicable if, in fully matured lignin, methoxyl groups were fixed by the lignin molecule in addition to that fixed by polyuronide. In this case, lignin from the bark may not be fully methylated. In the present investigation, Klason lignin from the inner bark contained 7.5 per cent methoxyl, whereas lignin from the sapwood contained 14.9 per cent. On the other hand, an analysis of the Klason lignin from the inner bark revealed that it was very intimately mixed with other (largely nitrogen-containing) materials that have no methoxyl groups. The presence of protein degradation products in the lignin would also account for the lower percentage of methoxyl found.

The study of the composition of the living part of wood is being continued as rapidly as possible both at The Institute of Paper Chemistry and at the University of Arizona.

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IN THE LABORATORY

The Quantitative Chromatography of Silk Hydrolysate

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Partition chromatography has become an important tool in the analysis of proteins. Especially as carried out on strips of filter paper according to the techniques of Consden, Gordon, and Martin (*2*), it has provided an extraordinarily rapid and sensitive way of recognizing the numerous amino acids in an hydrolysate of a protein. We have found that under proper conditions it can also provide quantitative information about the amounts of these amino acids.

As is well known, this chromatographic analysis proceeds by allowing a small volume of hydrolysate on filter paper to be leached out by a solvent saturated with water while the paper is hung up in an atmosphere saturated with vapors of this solvent and water. Under these conditions, the rates of flow of the acids present are often so different that after two or three days all of a component will be localized in a band or spot on the paper. Those acids that migrate at about the same rate in one pair of solvents can often be separated in another; or the paper can, after the first separation, be turned through 90° and the separation continued with another solvent. Since the rates of migration on an inert substrate such as paper are primarily determined by partition coefficients between the solvents used, a knowledge of these coefficients permits recognition of the acids in the bands or spots of the finished chromatogram.

Valid quantitative results can be obtained from such an analysis only if it is carried out under controlled conditions which allow comparison with a simultaneously prepared chromatogram of a known mixture of amino acids and if it involves bands well separated from one another. To obtain these, several runs, using different solvents, may be required.

There are several ways of determining the amount of amino acid in a band. It can be done by extracting the acid and making a micro-Kjeldahl determination of the extracted nitrogen. Filter paper with which we have worked has contained amounts of nitrogen comparable with that in the extracted acid, and colorimetric procedures have proved more convenient and accurate. In the techniques as finally adopted, chromatograms of the hydrolysate and of the standard mixture of acids were always prepared at the same time in the same jar. At the conclusion of the run the two were dried together without resort to heating, and color was developed by spraying the papers with ninhydrin (0.1 per cent in butanol) and heating to 90° C. for 5 minutes, using the entire paper or vertical stips cut from it to provide a guide to the positions of the bands. If entire sheets were colored, the corresponding band on the unknown and the control were cut out, their colors extracted (preferably with acetone), and the extracts made up to known volume, diluted, and compared in a colorimeter. These steps were always carried out promptly and under the same conditions for unknown and control. When the bands were sufficiently separated on the finished chromatogram so that the amino acid-containing areas of the filter paper could be identified by reference to a strip cut from its edge and colored with ninhydrin, the amino acids themselves were often leached from the paper before treatment with ninhydrin. Satisfactory results have also been obtained by applying the hydrolysate in a series of dilutions as drops and by setting up composite standards in which the known amino acid mixture was also applied at a series of dilutions. In this case, color was developed on the papers, and the amount of an amino acid in the unknown was determined by finding spots of equal intensity and area on the standard and unknown papers. This "spot-dilution" technique is especially promising.

Though knowledge of partition coefficients is often sufficient to identify the amino acids present on a chromatogram, a more direct means is frequently desirable. Electron diffraction has proved particularly useful for this purpose. If sufficient care is taken in making the preparations, excellent diffraction patterns can be obtained (*3*) with an RCA type EMU electron microscope from very few micrograms of amino acid extracted from a spot or band—and the identification this provides is unequivocal. Such diffraction observations have identified traces too small for quantitative determination and have proved useful as indices of purity of the extract from a band.

TABLE 1

The Amino Acids of Silk

Amino acid	HCl hydrolysate of silk		Artificial mixture		Previous analyses	
	Color analysis	Spot dilution	Composition	Estimated spot dilution	(a) (*1*)	(b) (*4*)
Arginine	2.4	0.8			0.76	0.7
Glycine	39.9	42.4	43.4	39.0	43.8	40.5
Serine	12.7	11.9	1.9	3.2	13.6	1.8
Alanine	37.6	34.0	26.8	29.6	26.4	25.0
Proline	trace	trace	1.1	—	1.0	1.0
Valine	4.4	5.7			—	—
Isoleucine	trace	2.5	2.7	3.8	2.5	2.5
Phenylalanine	absent	absent	12.3	12.5	1.5	11.5
Tyrosine	5.9	8.3	11.8	14.6	13.2	11.0
Methionine	absent	absent			2.6	—
Histidine	—	—			0.1	0.1
Threonine	—	—			1.4	—
Total	102.9	105.6	100.0	102.7	106.9	94.1

This work has been carried out in the search for methods applicable to the analysis of purified viruses. To determine the accuracy of the foregoing and other procedures tested, however, we have made many analyses of silk, chosen because of its relative simplicity and the detail with which it has been studied by classical methods of analysis. The data in Table 1 illustrate the kind of accuracy furnished by these chromatographic procedures.

The results of columns 2 and 3 are single readings of representative chromatograms. For column 2 the acids were extracted from the paper after treatment with ninhydrin and measured colorimetrically; for column 3 the procedure was that described above as the spot-dilution technique. A comparison between columns 4 and 5 indicates the kind of agreement to be expected between duplicate runs. Previous analyses are reproduced in columns 6 and 7.

There are several significant differences between our results and the earlier ones. We agree with analysis (a) and disagree with analysis (b) in finding a high serine content and little, if any, phenylalanine. According to chromatographic analysis, there is less tyrosine and more alanine than was found by earlier methods. Valine was not previously identified; on the other hand, there has been *no* chromatographic evidence for methionine. The solvents used in this work were not appropriate for determinations of the other two acids, histidine and threonine, that have been reported.

The methods used and results obtained in this study will be described in detail elsewhere.

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Illuminator for Melting-Point Blocks

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Berl and Kullman (*2*) and Bergstrom (*1*) have described copper melting-point blocks which give more accurate results than the open beaker type of apparatus. However, the copper block is only as accurate as the amount of illumination supplied to its interior. Most investigators have used quartz rods to conduct the light to the interior. Although this gives a good source of light, the rods are expensive and subject to breakage. To overcome these disadvantages, the illuminator described below was constructed.

A piece of aluminum alloy tubing, $\frac{7}{16}$ inch in diameter, was bent to form a circle 10 inches in diameter. A piece of sheet aluminum alloy $\frac{1}{16}$ x $1\frac{1}{4}$ x 10 inches was bolted to this circle and trimmed so that the outside edge was 9 inches long and its center was $2\frac{3}{8}$ inches from the center of the block. Two cones were constructed from sheet copper. One end had a diameter of $\frac{11}{16}$ inch, and the other tapered to $\frac{5}{16}$ inch. Two brass light fixtures, each holding a 7-watt lamp, were mounted in these cones and then bolted to the aluminum ring. Wires from the lamps passed through the ring and out at the rear, where they were attached to a female plug (Fig. 1).

The illuminator was connected to the block by glass rods, $\frac{5}{16}$ inch in diameter, cut to fit the block used. The entire apparatus usually is mounted by clamping it to a ring stand. The addition of a magnifying glass or telescopic sight mounted in the center of the cross brace and sighted on the observation hole in the block completes the apparatus.

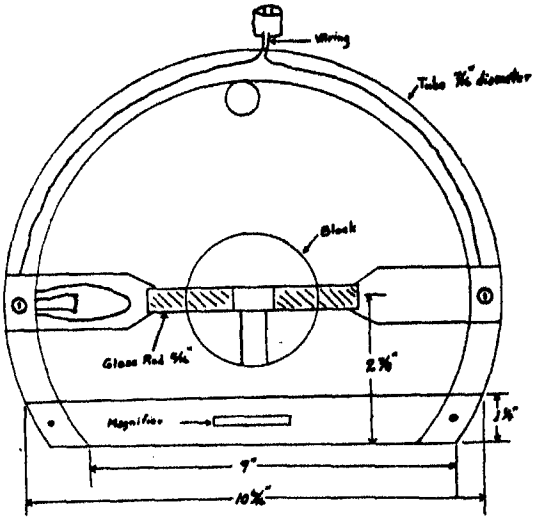

Fig. 1

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Interference by ATP in the Estimation of Coenzyme I

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Chemical and physicochemical methods cannot be relied upon for the estimation of coenzyme I in tissue extracts; biochemical methods involving the use of enzyme systems are the most advantageous. Among these, the most widely used has been the fermentation method of von Euler and Myrbäck (*4*), where apozymase is used as the source of enzymes and the coenzyme is estimated by the volume of carbon dioxide liberated when excess sugar is fermented in the presence of inorganic phosphate and hexose diphosphate. In the method due to Warburg (*6*), partially purified enzymes, protein A and protein B, obtained from Lebedev's juice, are used, the other components of the system being coenzyme I, adenine nucleotide, Robison ester, acetaldehyde, phosphates and magnesium, manganese and ammonium ions. Jandorf, Klemperer, and Hastings (*2*) described a new method based on the catalysis by coenzyme I of the breakdown of hexose diphosphate in the presence of arsenate, a dialysed aqueous extract of cat muscle being used as the source of glycolytic enzymes. Haas (*1*) has suggested that coenzyme I may be estimated spectrophotometrically by the reduction of 2,6-dichlorophenolindophenol by dihydrocoenzyme formed in the presence of suitable substrate and apodehydrogenase. Very recently (*3*, *5*) two other methods have been reported from this laboratory.[2] In one, use is made of lactic apodehydrogenase and diaphorase in the test system, and in the other, aetiozymase is used as the source of aldolase and triose phosphate dehydrogenase. While all these methods give satisfactory results with comparatively pure solutions of coenzyme I, no unequivocal proof has yet been furnished as to their applicability to tissue extracts, where interfering substances might be present.

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[1] Government of India scholar. The author is grateful to J. B. Sumner for his interest in this investigation and to the Rockefeller Foundation for financial support.

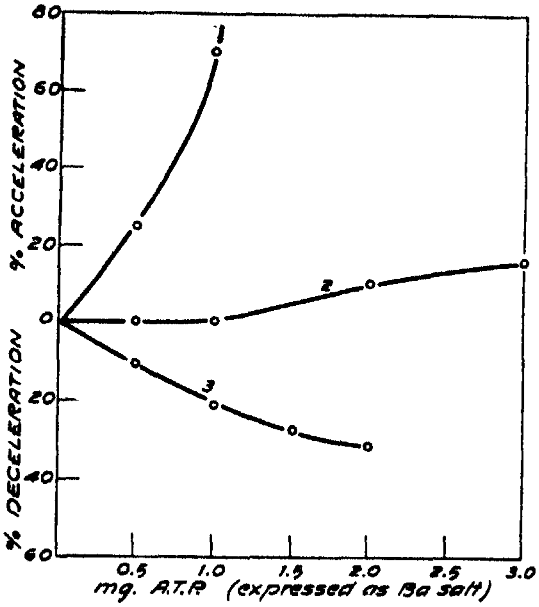

FIG. 1. Method of von Euler and Myrbäck, 1; method of Krishnan, 2; method of Jandorf, *et al.*, 3.

The present report deals with one such possible interfering substance, namely, ATP, which is present in certain tissues in concentrations several fold that of coenzyme I. We have worked with three different test systems: the fermentation method of von Euler and Myrbäck, the manometric method of Jandorf, *et al.*, and the oxygen-absorption method of Krishnan (*3*). The concentrations of ATP, expressed in terms of the original dibarium salt, ranged from 0.1 to 3 mg./reaction flask, and that of coenzyme I, from 8 to 16 γ. The results obtained are represented in Fig. 1.

It is apparent that very small amounts of ATP (of the order of 0.1 mg.) have practically no effect on results given by the methods mentioned above. This is in agreement with the statement by Jandorf, *et al.*, who found that ATP is without influence on the course of the reaction developed by them. However, when the concentration is increased, it exerts a pronounced effect on the rate of the reaction. In the fermentation method of von Euler and Myrbäck (where readings were taken of the maximum rate of fermentation in a 10-minute interval, as recommended by Axelrod and Elvehjem) and in the oxygen-absorption method of Krishnan, the reaction rate is accelerated, whereas in the method of Jandorf, *et al.* the effect is of an inhibitory nature. It may also be noted that the interfering effect of ATP is least in the oxygen-absorption method. This is to be expected, since ATP is not known to influence the stages of glycolysis used in the test system. ATP exerts its maximum effect on the fermentation method utilizing apozymase[3]—an effect different from that of hexose diphosphate, which is believed to function merely by decreasing the induction period.

The conclusion has to be drawn, therefore, that in such tissue extracts and test systems, where there is a preponderance of ATP over coenzyme I, appreciable errors will be introduced in the estimation of the latter by the conventional biochemical methods.

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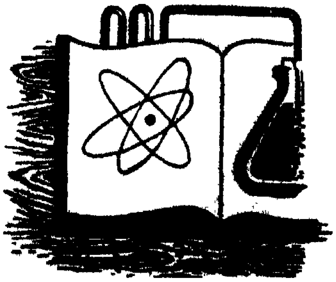
[2] Details of these methods will be published elsewhere.

[3] Apozymase was prepared by drying brewer's bottom yeast (obtained from Haberle Congress Brewing Company, Syracuse) for 24 hours at room temperature and washing 5 times with large volumes of distilled water. The specimen of ATP used in the above experiments was supplied by I. C. Gunsalus, to whom our grateful thanks are due.



Book Reviews

The collected papers of C. S. Hudson. (Vol. I.) Raymond M. Hann and Nelson K. Richtmeyer. (Eds.) New York: Academic Press, 1946. Pp. xxxv + 898. (Illustrated.) $15.00.

To celebrate the occasion of the 65th birthday of C. S. Hudson, the Division of Sugar Chemistry and Technology of the American Chemical Society undertook the publication of these "Collected Papers" in recognition of Dr. Hudson's contributions to the chemical literature during more than four decades.

Volume I comprises 118 papers from a total of 247. The papers are placed in groups arranged according to subjects. No changes have been made in the original texts except where minor errors have been encountered. The titles of the sections follow: (I) The Forms of Milk Sugar. Physical Chemistry of Solutions. Mutarotation of Sugars. (II) Enzymes: Studies of Invertase, Amylases, and Emulsin. (III) Preparation of Sugars. (IV) Rules of Isorotation. Acetyl Derivatures of Sugars and Glycosides. (V) Lactone, Phenylhydrazide, Amide and Benzimidazole Rules.

The papers of this brilliant scientist, collected as they are here, will be indispensable to those who follow the sugar field closely. Much of the fundamental work on sugars which led to a clarification of their characteristics and their structures is found in them.

Of no minor interest is Dr. Hudson's autobiography, which is included. It is a permanent record of the life of the leading sugar chemist in the United States and one who has done much for the prestige of American science.

ROGER ADAMS

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X-ray diffraction studies in biology and medicine. Mona Spiegel-Adolf and George C. Henny. New York: Grune and Stratton, 1947. Pp. viii + 215. (Illustrated.) $5.50.

In the preface the authors present this book as the first "comprehensive survey on x-ray diffraction in biology and medicine in the English language." As such it is welcomed and should serve a purpose. They have also taken "the opportunity to review [their] own diversified studies in this field during the last ten years and to present them in the framework of the pertaining literature against a broader background. Since this presentation is made for the use of the biologist and research physician, purely physical and mathematical discussions have been omitted wherever it was possible to do so without sacrificing accuracy." It is in these aims and their embodiment in the text that one finds limitations to the usefulness of the book.

The physician or biologist will be prepared neither to read critically nor to conduct research reliably in the field by mastering the introductory three chapters on theory, practice, and pattern interpretation, without recourse to much wider perusal of the references cited. By avoiding or sketching briefly the more technical phases of the physics, mathematics, and crystallography of x-ray diffraction investigation, the authors have failed to furnish adequate background for even an appreciation of the scope and significance of the contributions which x-ray diffraction has and can make to biological sciences.

Chapters IV through XII summarize special aspects of diffraction studies, covering applications to carbohydrates, amino acids and derivatives, proteins, nucleic acids and nucleoproteins, muscle, lipids, nerves, steroids, and finally, bones, teeth, and concretions. Perhaps the most useful features of the book are the bibliographies at the ends of these chapters. Unfortunately, each list cannot be trusted to be complete, even up to the date (1945, some 1946) at which the references terminate. For example, work at Pasadena on amino acids, at Ames on amylose, and the more recent views of Cox on pyranose ring structure are either missing or scarcely mentioned.

In all of the discussion the vital structural significance of diffraction data is pretty much neglected. Measurement of a spacing has little but identificational importance, without relation to its crystallographic or structural implication. Often the final steps of diffraction analysis are impossible in complex systems, but where they can be carried out, even partially, the information thus gained is of primary importance and should not be slighted to avoid physical and mathematical complications. Only brief mention is given to the Fourier projections which are so rapidly becoming an essential part of the language in which the results of diffraction study are expressed.

The book is attractively bound, printed on excellent paper, and profusely illustrated. Many of the reproduced "diffractograms" seem unnecessary, however. About 60 per cent of them are of diffuse unoriented or powder type, corresponding to the unwarrantedly large proportion of the text devoted to the simpler but also less significant facts that can be deduced from diffraction-poor diagrams.

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Scientific Book Register

CLARK, HUBERT LYMAN. *The echinoderm fauna of Australia; its composition and its origin.* (Publ. 566.) Washington, D. C.: Carnegie Institution of Washington, 1947. Pp. iv + 567. $4.00, paper; $4.50, cloth.

LEIGHTON, DOROTHEA, and KLUCKHOHN, CLYDE. *The Navaho individual and his development.* Cambridge, Mass.: Harvard Univ. Press; London, Engl.: Oxford Univ. Press, 1947. Pp. xi + 277. (Illustrated.) $4.50.

MACDOUGALL, W. B. *Plants of Grand Canyon National Park.* (Rev.) (Bull. No. 10.) Grand Canyon, Ariz.: Grand Canyon National History Association, 1947. Pp. 126. $.50.

NATHAN, DAVID S., and HELMER, OLAF. *Analytic geometry.* New York: Prentice-Hall, 1947. Pp. x + 402. (Illustrated.) $3.50.

THOMAS, ISLYN. *Injection molding of plastics.* New York: Reinhold, 1947. Pp. viii + 534. (Illustrated.) $10.00.

WISELOGLE, FREDERICK Y. (Ed.) *A survey of antimalarial drugs, 1941–1945.* Ann Arbor, Mich.: J. W. Edwards, 1946. Vol. I: Pp. xi + 536; Vol. II, Pt. 1: Pp. 987; Vol. II, Pt. 2: Pp. 988–1921. $30.00.

Chromosome Structure Under the Electron Microscope

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OUR PRESENT KNOWLEDGE OF chromosome structure, based entirely upon light microscopy, has revealed that the basic structure of the chromosome is a long, slender thread of granules or chromomeres. These chromonemal threads are wound or coiled compactly in forming the chromosome of midmitosis. It is in the prophase of mitosis, before they have become closely coiled, that the individual chromonemal threads may be observed to best advantage. In a critical review with a bibliography of more than 700 titles, Geitler (*5*) has brought together extensive literature bearing on chromosome structure.

Since it has long been recognized that the structure of chromatin is most clearly observable in the early prophase of mitosis, anyone would plan to attack this problem in prophase. The researches of McClintock (7) on meiotic prophase chromosomes have, in fact, demonstrated directly that in the hereditary mechanism we are concerned with a linear order of visible particles or chromomeres united in some way into a thread. She has shown that definite sections of these pachytene chromonemas may, by their manner of synaptic approximation, be related to peculiarities in the genetic constitution of the plant. This was probably the closest demonstration by direct observation of the essential correctness of Morgan's theory of the linear arrangement of genes on chromosomes that had appeared up to the discovery and interpretation of giant salivary chromosomes, independently by Painter (*8*) in *Drosophila* and by Heitz and Bauer (*6*) in *Bibio*. Salivary chromosomes have also confirmed the linear arrangement of genes and led to a better understanding of the nature of the genic elements.

The limit of resolution in light microscopy was approached before the turn of the century with the perfection of modern lens systems. Improvement since Abbe computed the lens formulas that are still in use may be expected to result only from greater precision or perfection of workmanship in manufacture. Theoretically, one should be able to distinguish two objects when separated by about 1/5 μ or more—an optical perfection usually not realized. The employment of light of short wave length and ultraviolet improves resolution above this, but the use of ultraviolet depends upon photographic images rather than direct visual methods. The electron microscope gives, theoretically, 100 times better resolution than microscopes dependent upon light; it would separate points that are 1/100 of these distances apart and should therefore give much clearer definition.

Some of the conditions necessary for the examination of objects with an electron microscope are very discouraging to biologists. The objects to be examined must be placed in a very high vacuum and cannot be observed while immersed in fluid media. They are unavoidably subjected to extreme desiccation. Wyckoff (*12*) has recently given an account of the special requirements in preparations examined with the electron microscope. These conditions would not arouse much enthusiasm on the part of cytologists.

Images of dried objects, when examined under light microscopy, appear very unfamiliar and are frequently not recognized as identical when compared with the image of the same object while immersed in water, oil, or other fluid media. Bacteriologists dry the suspensions of bacteria on slides as a routine procedure before and after staining them, but during examination these are usually immersed in oil or other fluid medium of high refractive index. However, biologists must become accustomed to a study of the dried remains of organic matter and learn to employ techniques that differ radically from routine methods.

In using the electron microscope, preparations of objects may be carried out under light microscopy. Hence, one must learn to recognize selected objects in both conditions (immersed in fluid as well as dry), even when the dry object shows much less detail and appears very different from the customary mount.

Since the installation of an electron microscope at the University of Illinois in 1942 it has been the writer's ambition to render service in adapting this equipment to the study of chromosomes. Sporadic efforts made to mount and observe prophase chromosomes failed completely, but such efforts serve to familiarize one with the general technique and requirements in selection of objects suitable for study. It was soon realized that very special techniques must first be developed. For long periods all efforts other than reflection and speculation were abandoned. The present period of intensive experimentation began in June 1946.

Schmitt's claim (*11*) that sections of organic tissue must be cut as thin as 0.1 μ or less in order to be sufficiently penetrated by electrons to form images may be an overstatement, but he did not specify degree of magnification and definition. Claude and Fullam (*4*) have actually obtained electron micrographs from sections 0.3–0.6 μ in thickness but under magnifications not greatly exceeding those attainable with light microscopy. Their photographs, made at initial magnifications of 1,650, demonstrate that electronically recorded images actually show much greater resolution than those of photomicrography and that they are subject to considerable enlargement. However, sections of more highly magnified organic objects should be made much thinner than has been attainable thus far.

Porter, Claude, and Fullam (*9*) have given electron micrographs of parts of entire cells obtained from tissue cultures—cells derived from chick embryos. Due to their thickness, these were photographed at magnifications of 900–1,600 and enlarged to ×15,000. In the photographs the superior resolving power of the electron microscope is evident by the sharp contrast and definition of the images. Only resting interphase nuclei were included. In regions of nuclei these isolated cells were too thick to show structure. As far as the writer has been able to find, chromosomal structure has not been certainly demonstrated with the electron microscope.

Some preliminary results on "lampbrush chromosomes" had been reported from our laboratories by Clark, Barnes, and Baylor (*2*) and illustrated in Clark, Quaife, and Baylor (*3*). Interpretations of these results have been complicated through subsequent investigations by Quaife (*10*) on protein salt systems, and some of these investigations remain incomplete and unpublished.

It occurred to the writer that the difficulty of obtaining small, thin objects might be overcome by teasing parts from cells. This is essentially the general method employed by Schmitt (*11*) in the study of muscle and collagen fibers. However, this technique involves new difficulties when used in a study of cells. Cytologists will realize at once that a thread stained with hematoxylin and located within the nuclear membrane is usually interpreted as part of a chromosome; similar objects encountered in cytoplasm outside of the nuclear membrane might be interpreted as mitochondria, chromidia, etc. When a cell is torn open and dismembered, how can one be certain as to the origin of the residues? Even when the cell has been stained, the chromosomes are not the only objects that may possess color.

Some of these difficulties have been overcome. It was found possible to recognize parts of chromosomes in prophase after they were desiccated on a slide. Through repeated rehearsal of dissection methods it was possible to isolate parts of chromosomes and separate them completely from the surrounding cytoplasm. Parts of prophase chromosomes from the pollen mother cells of maize could be isolated by operating on individual cells that had been transferred to clean slides. Furthermore, a technique has been developed by which an object such as an isolated bit of chromosome, definitely recognized as coming from within the nucleus, may be dried, mounted in a film, and transferred to the object holder of an electron microscope. The selected object is carefully centered when mounted or so related to peculiarities of the mount that its position may be recognized in the finder of the microscope. There is still some lack of perfection in this technique, which may be responsible for the considerable loss in contrast and definition thus far obtained from these objects at the magnifications used. An account of the technique will be given in detail in another publication. It is from such isolated bits of prophase chromosomes that the accompanying electron micrographs were obtained.

While the writer has dissected and prepared all objects and selected the images to be photographed, he does not operate the electron microscope by himself.[1] Another microscope, a new Universal model, was used in one session on January 2, 1947, at the Battelle Memorial Institute, Columbus, Ohio.[2] This new model gave excellent results and seems ideally adapted for biological investigations such as these. With more patience, equally good and some superior electron micrographs were obtained with the older RCA model (Serial No. 1) installed in G. L. Clark's laboratory at the University of Illinois. Even though this microscope is capable of higher magnifications, nearly all of this work was done at initial enlargements of 10,000–12,000. There are now more than 50 negatives showing chromosome structure in maize.

The picture of chromosome structure obtained has not greatly altered the general concept derived from light microscopy. There is close agreement with previously known features. Some details only partially known may be ascertained, and the method gives promise of supplying information concerning many other unknown or little known facts.

There is a thread that connects the granules or chromosomes or to which a great variety of chromomeres are attached. In places this thread appears to be flattened, and granules appear to be attached laterally. Both its width and thickness may not be constant. Some regions would indicate a width of 100 mμ or more in places that may border heterochromatic regions. The smallest values estimated for width were 50, and the smallest for thickness were about 30 mμ. Granules were usually found attached in pairs at the rate of 4–5/μ. In regions in which they were most crowded there were as many as 8/μ along the length of the thread. In some regions there were relatively few granules, but one cannot be certain that some of these may not have become detached and washed away during dissection and mounting. Data such as these, when given with greater precision, may be useful in estimating the actual size of the smallest visible elements of the gene.

The chromomeres or granules that are found attached to the supporting thread vary through a wide range of sizes, shapes, and "density." Some are spherical and relatively translucent to electrons and range in size from 75 to 165 mμ. The spherical translucent granules are observ-

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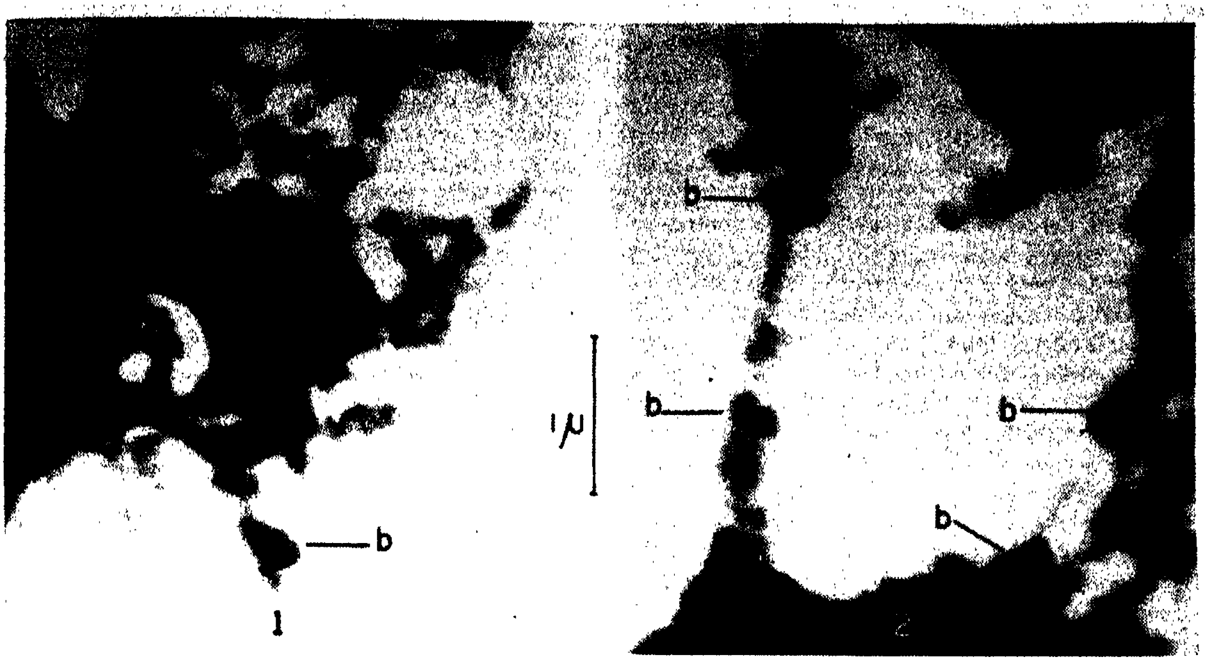
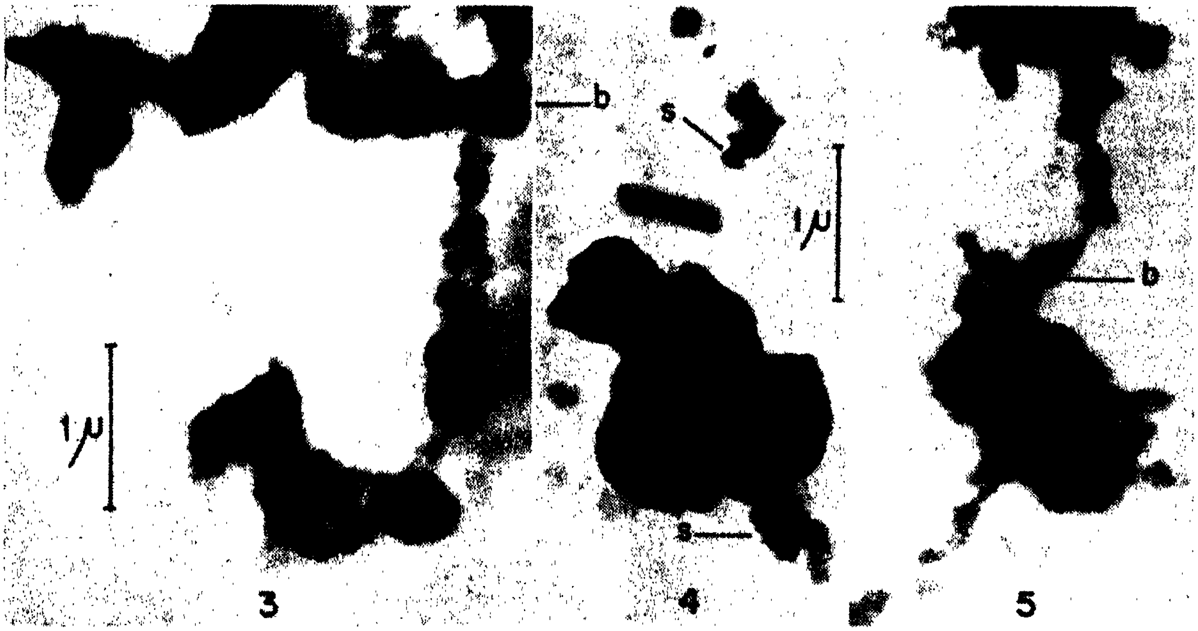
[1] The writer is greatly indebted to A. Eisenstark, who is employed by the Graduate School of the University of Illinois to operate this equipment for biological departments; to Martha B. Baylor, who was in charge of the electron microscope prior to September 1, 1946; and to H. B. Gillin who substituted for Mrs. Baylor on several occasions.

[2] This was made available through the courtesy of the Institute and Charles M. Schwartz, who operated the equipment.



FIGS. 1-5. Electron micrographs of fragments of chromosomes at or near pachytene, dissected from pollen mother cells of maize. All figures are × 20,000, enlarged from original recording made at × 11,000, except Fig. 4, which was recorded at × 12,000, and reproduced here at × 26,000. The granules are shown attached to a "linin" thread and vary greatly in size, shape, and "transparency" to electrons. Those shown at b scatter the electrons and appear as if "opaque". Those shown at s are spool shaped. Fig. 5 shows a long thread in snarls which appear as chromomeres under light microscopy.



able in all except Fig. 4. The spherical and spheroidal granules that appear as if opaque to electrons (Figs. 1-3, b) range in size from 85 to 660 mμ. Spheroidal "dark" granules were seen that may be estimated at 150 x 180, 132 x 220, 210 x 330, and 330 x 430 mμ.

Very many other granules seem to be lobed bodies—possibly spool shaped. Some of these may be seen in Fig. 4 near the s markers. When symmetrically lobed, these suggest the possibility that they are granules in stages of division, which could also apply if they are actually more nearly spool shaped. In some regions these measure approximately 150 x 210 mμ; others were estimated at 130 x 165 mμ.

Synapsis may be observed in some of the chromonemal threads where they appear paired. Fig. 3–4 shows a section of two synapsed chromonemal threads, each of which may be double. However, Figs. 1, 3, and 5 suggest single threads, the double nature of which may be due to doubling of the chromonema itself, giving sister strands as in ordinary mitosis.

Nothing decisive and not previously recognized concerning synapsis is shown, nor would interpretation be considered critical in material that has been subjected to considerable manipulation in dissection.

Not all objects that may appear as chromomeres under light microscopy are individual units. Fig. 5 illustrates this, for here the bodies about 1 x 2 μ in size that are visible under light and would be interpreted as chromomeres are actually made up of snarls of beaded threads. Similar snarls in Figs. 1 and 2 would appear as rounded beads when observed under light microscopy so near the limits of resolution.

The granules that appear smooth and spherical in the electron micrographs may represent homogeneous substance, made up of uniform molecules. This might suggest that we are now actually dealing with the genic elements, with only the individual molecules of these units remaining unrevealed.

But where is the gene? Unfortunately, the answer may not be given with assurance. If the granules are considered as the genes, then these units are not uniform in size and shape. Granules may be found among those that appear to be homogeneous that range in size from 50 to 750 mμ. They vary also in shape and density to electronic penetration. If these granules are considered as initial products of the gene, one might more easily appreciate the diversity in their appearance.

The gene of genetic interpretations may, however, represent sections of chromonemal threads, including several kinds of granules. The work of Bridges (*1*) has shown, in fact, that some genes are composed of several alternations of dark and light bands in the salivary chromosomes of ***Drosophila***. A corollary to this would suggest that numerous unlike granules may be included in the gene referred to by geneticists. It would appear logical to consider the granules shown here as parts of the elements of genes. This suggests that the gene is composite.

However, the chromonemal threads to which the granules are attached cannot be excluded from this concept. This thread is a vital part of the living substance that divides during the mitotic cycle, and if the granules are visible products of molecules, incorporated within the thread to which they appear attached, then we should not exclude, while they remain attached, these granules as parts of the genic elements. In a somewhat different sense the genic element would therefore be composite, even if one considers the position of a granule as its locus. This unit would consist of at least one molecule within the supporting thread that duplicates itself during each mitotic cycle and also produces the substance given off to form granules. It may be presumed that the granules or their derivative substance would be given off to produce effects elsewhere within the cell.

It may be expected that the use of the electron microscope will reveal much in the study of chromosome structure. In any event, it would seem that a concept of gene elements should emerge from a continued study of chromosomal structure by this means.

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The First Pan-African Congress on Prehistory

Wendell Phillips

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THE FIRST PAN-AFRICAN CONGRESS ON Prehistory was formally opened in the Town Hall of Nairobi on January 14, 1947, by the Governor of Kenya, Sir Philip Mitchell.

Speaking in French, Prof. L'Abbé Breuil replied in part as follows:

> It is barely a century ago that English and French scientists including inspired men like John Frere and Boucher de Perthes, soon to be helped by those grandfathers of geology, Lyell and Prestwich, and by biologists like Darwin and Huxley, discovered that humanity went back to times far more remote than those of man's ancient history. Both in this organic development and in this material civilization, the species to which we belong has taken innumerable aeons to reach the present Parnassus of spirit, leaving behind forms today extinct, while passing through a series of glacial and interglacial ages. The importance of this discovery in the story of man's history equals the discoveries of Copernicus and Galileo in the field of astronomy. Our old nations are now becoming grandfathers, and we, the workers of yesterday, must realize that from the Nile to Cape Town and in Kenya which is like the very heart of this continent our work is developing beyond all hopes.

Following addresses by several other delegates the Abbé Breuil was unanimously elected president and Robert Broom, vice-president, of the Congress.

All of the scientific papers and discussions of the Congress were encompassed in three sections: Prehistoric Archeology, L. S. B. Leakey (chairman); Human Paleontology, Raymond Dart (chairman); and Geology, General Paleontology, and Climatology, Alex du Toit (chairman).

The Congress was conceived, organized, and directed in all of its aspects by L. S. B. Leakey, curator of the Coryendon Museum, whose untiring efforts were largely responsible for its great success.

An interesting feature of the Congress was that, of the 55 official delegates representing 26 different countries, 25 were not prehistorians: 5 were paleontologists; 5, anatomists; and 15, geologists. Those in attendance agreed on the importance of this collaboration from a group of specialists in different fields of science who could bring their specialized knowledge and mutual interest to bear on the problems of research in prehistory.

Although the main theme was prehistory, the organizing secretary wisely broadened the scope of the discussions to include such relevant subjects as climatic changes, pluvials, and glacials in relation to prehistory; Quaternary geology in relation to prehistory; and those aspects of paleontology which intimately concern prehistory, such as the use of fossils for dating deposits and the question of African ape remains and their relation to the problem of the origin of man.

As a member of the Subcommittee on Human Paleontology my interest was focused mainly on the fossil, australopithecine man apes from South Africa, and the lower Miocene primates from Kenya. Following Prof. Dart's epoch-making discovery of the Taungs child in 1924, it remained for the genius of Robert Broom to unfold new types of *Australopithecus*.

At the close of the Congress Dr. Broom took me to the Kromdraai and Sterkfontein deposits. These have one important feature in common: all the fossils recovered from them, including the types of *Plesianthropus* and *Paranthropus*, were in travertine breccia in old limestone caves which have so far revealed no traces of fire and artifacts. A possible exception to this may be the Cave of the Hearths in Makapan Valley, where C. van Reit Lowe has discovered hand axes in a bone breccia with an associated fauna similar to Sterkfontein and Kromdraai. Further work is required in this region to ascertain whether or not australopithecines are present.

At the Congress Le Gros Clark presented a summary of the important intermediate characters of these man apes which was strongly reminiscent of the prior conclusions of W. K. Gregory and Milo Helman, who studied these forms during their South African visit in 1938. If Dr. Broom is correct in placing the australopithecine forms in the early Pleistocene or even the late Pliocene, this might exclude them from the direct ancestral stock of the Hominidae. This does not remove them from a position of prime importance, however, for they are regarded by many as slightly modified survivals of the ancestral stock from which man arose.

Recent discoveries of lower Miocene primates by L. S. B. Leakey and D. G. MacInnes at Rusinga Island in Lake Victoria are of great interest. The new find of an almost complete jaw of *Proconsul* shows characteristics which point to a close relationship with the dryopithecine apes of Europe and India.

Although *Proconsul* may not be on the human line, it has a number of characteristics which suggest man as well as the simian forms. Thus, *Proconsul*, with the recent associated discoveries of the jaws and teeth of *Limnopithecus*, which may be an early member of the gibbon group, and *Xenopithecus*, which probably belongs to the same stem as the orangutan, helps to bridge the great gap between the Fayum of Egypt, where we find

Propliopithecus and *Parapithecus* in the Oligocene, to the dryopithecine apes of the upper and lower Pliocene and Miocene of Europe and India.

The first formal resolution of the Congress was that the continuity of the work should be insured by holding such a congress every four years. This brought about an immediate invitation from Field Marshal Smuts to hold the next meeting in the Union in 1951.

Confusion which has arisen in attempting to date events in Africa has been due largely to the fact that European Pleistocene stages have been applied to Africa. These are not suitable because of the great difference in conditions in Africa and Europe. Thus, a resolution was passed that European terms for that portion of the geological record which covers the period of man's development in Africa should be dropped and that a purely African nomenclature based on the stratigraphic sequences in Africa, should be employed.

A permanent consultative committee was established at the close of the Congress to advise on the use and application of terms to describe the different ages and stone cultures in Africa. This committee has five members, South Africa, East Africa, West and Central Africa, Northeast Africa, and Northwest Africa and the Sahara, each being represented by one member. African terminology has always been difficult for foreign students, and the creation of this new committee will contribute to a better understanding by eliminating ambiguous names.

Finally, a number of resolutions were passed which are to be submitted to the governments of the various African territories where prehistory has not yet been officially recognized and where it is hoped archaeological surveys will be established along the lines of those in Egypt and the Union.

To many of the delegates the excursions undertaken during their stay in East Africa were of even greater interest than the meetings. The first of these was made to the Great Rift Valley, where the delegates visited the controversial Cartwright site containing the cultural remains called Pseudo-Stillbay; the Kariandusi site, developed as a "museum on the spot," where an Acheulean living site has been preserved; and the Enderit Drift, which includes the type section of the Makalian wet phases. A visit was then made to Gambles Cave on the Mau escarpment, which is the type section for the upper Kenya Aurignacian cultures and where remains of Aurignacian man had been found. The third trip took us to the scene of the spectacular discoveries at Olorgesaillie. Here, some 43 miles from Nairobi, on the road between Lake Magadi and the extinct volcano, Suswa, Mrs. Mary Leakey in 1942 discovered, scattered over the erosion slopes below a cliff of ancient lake beds, literally hundreds of perfect hand axes and cleavers which were being washed out from a series of old land surfaces interbedded in Pleistocene lacustrine deposits. Trial trenches had been cut, uncovering the actual living floors of the Acheulean hunters. These beds were formed in a fluctuating lake and between each successive rise Acheulean man camped on the shore close to the water.

At least 10 ancient camp sites, each covered in turn by the periodic flooding of the area, have been discovered. In direct association with the hand axes and cleavers, there are numerous fossilized remains of the extinct giant baboon (*Simopithecus*); the straight-tusked elephant (*Elephas antiquus*); and giant pigs and horses, all with the majority of their bones split open for purposes of marrow extraction and with the skulls broken in order to obtain the brains.

A protective shelter has been constructed over each excavated site. Kenya, with a white population numbering only a few thousand, is far ahead of most countries in the development of such unique educational features. On this excursion, the Olorgesaillie Museum was formally opened to the public by Sir Gilbert Rennie, Chief Secretary of Kenya.

The second excursion was made to the prehistoric obsidian mines in the Njorowa Gorge, south of Lake Naivasha, which had once been the overflow channel of a large lake. After the lake had dried up and the channel had been abandoned, Stone Age man discovered an exposure of particularly fine obsidian, ideally suited for making tools. Many tons were mined with primitive stone implements, resulting in a tunnel through a hundred feet of solid rock.

The delegates assembled on January 24, 1947, for the final excursion, which took them over nearly 1,000 miles of southern Kenya and Tanganyika. One of the sites visited was Olduvai Gorge, where, over a distance of some 30 miles, there is an exposure of 300 feet of stratified human history contained in the numerous layers of lake sediments in both sides of the canyon. The total length of the exposure is over 135 miles. Of the five major deposits at Olduvai, the first four belong to the Kamasian Pluvial. In East Africa there are two major pluvials—the Kamasian and the Gamblian—followed by two minor wet phases, the Makalian and the Nakura. The lower part of the Kamasian is regarded as lower Pleistocene and the upper part as middle Pleistocene, while the Gamblian Pluvial represents the last third of the Pleistocene.

Bed I contains a fauna which includes *Dinotherium*, *Chalicotherium*, *Sivatherium*, and true elephants. Associated with the Oldavian Culture, there is a rapid evolution of the stone hammer technique which is continued through the 40-foot deposits of Bed III. Between Beds III and IV there occurs a 10-foot gravel band containing fine ovates with an "S" twist. Bed IV is the equivalent to Olorgesaillie and has a faunal assemblage containing many antelopes, as well as Hipparion, which is found throughout Kamasian Beds I–IV. Bed V is unconformable to the whole series.

In Serenje Hills the delegates were given an opportunity to study the cave paintings at Kisese Giraffe Shelter, Kisese Main Shelter, and the Cheke Rock Shelter. These paintings, preserved by penetration of the color through the rock, were superimposed, each period being revealed by its own distinctive style. According to the Abbé Breuil, the splendid line drawings of rhinoceroses giraffes, ostriches, and elephants were apparently related to paintings in European caves of an earlier period. Human figures with large, round heads and with bodies and limbs elongated out of all proportion, although not as artistic, demonstrated excellent movement in hunting scenes. The Abbé Breuil believes that the Tanganyika art is earlier than a large part of the Rhodesian and Southwest and Southeast African paintings and perhaps provides a key to the origin of art in other parts of the continent.

The collaboration of anatomists, paleontologists, and geologists with the prehistorians and the development of harmony and understanding between men in various scientific fields and of different nationalities seemed to be the most important single achievement of the Congress. The majority of delegates were sympathetic toward Darwin's view that Africa was the probable cradle of man. Whether or not this view is correct, within Africa there are still great possibilities for far-reaching contributions to the study of man's beginnings.

Obituary

Wilhelm Caspari

1872–1944

Wilhelm Caspari, for many years head of the Cancer Department of the Institute for Experimental Therapy Frankfurt am Main, Germany, died in 1944 in a ghetto concentration camp at Lodz, Poland. While there, he was conducted to give medical aid daily under guard to a German Army Hospital for infectious diseases and returned nightly to the ghetto. He died shortly before the liberation of Lodz by the Russians. His wife, exiled with him, was taken from the camp in 1942 and since then has not been heard of, in spite of extended searches made by the Joint Refugee Committee. A tragic feature was that Prof. Caspari's oldest son, who had been in this country since 1938, had obtained, in 1941, an American visa and funds for his parents. The visa arrived at the American Consulate in Frankfurt only two days after the Nazi deportation to Poland.

Prof. Caspari was born February 4, 1872, in Berlin, where his family had been established for generations. He studied chemistry and medicine at the Universities of Freiburg and Berlin and obtained his Doctor's degree at Leipzig in 1895. He joined the Department of Physiology, then under the direction of Nathan Zuntz, at the Royal Agricultural College, Berlin, where he remained until 1914. He served as a surgeon at the Western Front and, after the war, was engaged in rehabilitation of the wounded and invalids. In 1920 he succeeded L. Apolant at Frankfurt, remaining there in charge of the Department of Cancer until his dismissal in 1936 by the Nazi administration under the Nuremberg decrees.

As one of the pioneers of vitamin research, Caspari was early engaged in the metabolism of nutrition. He took part in Zuntz's expedition to Monte Rose for the purpose of investigating the influence of mountain climate on metabolism and participated in the classic, scientific reports of this undertaking. Later he became interested in the action of radiation on cell metabolism and growth—in particular, on cancer. With Emil Aschkinass he investigated the effects of X-rays on bacteria and was the first to apply radioactive material to the treatment of cancer. At Frankfurt, he worked on immunity, on resistance against cancer, on the effects of catabolic products of the necrotic part of tumors and of other dead or injured cell material, and on the influence of outside agents such as irradiation. His approach to the cancer problem was that of the physiologist, e.g. his studies on the influence of hormones and of nutrition on tumor growth. His experiments on the action of tumoraffine heavy metal salts on tumors, undertaken with Neuberg and Loehe, were interrupted by World War II.

In addition to the multitude of his published reports on experiments carried out by himself and his many fellow workers, he contributed to handbooks of physiology, cancer research and radiation. For many years he served on the council of the German Cancer Committee. He was an honorary Ph.D. of the University of Frankfurt, a corresponding member of the National Academy of Medicine of Spain, of the British Empire Cancer Campaign, and of the Physico-Medical Academy, Florence, Italy.

Ernest Schwartz
U. S. National Museum, Washington, D. C.

Robert Chambers
Department of Biology, New York University

Willis Linn Jepson

1867–1946

Willis Linn Jepson, dean of California botanists, died at his home in Berkeley on November 7, 1946, after a protracted illness, at the age of 79. He devoted a fruitful half century of zealous investigation to the systematic botany of his native state. His *Flora of Western Middle California* (1901), *Silva of California* (1910), *Manual of the flowering plants of California* (1923–25), and the monographic (uncompleted) *Flora of California* (1909–43) have firmly established him not only as the principal interpreter of the California flora but also as one of the greatest of American regional botanists. "Jepson's Manual" has been for more than 20 years the well-worn threshold for thousands of students to an understanding and appreciation of the remarkably diversified vegetation of the state.

Jepson was born of Scotch-English stock on August 19, 1867, at Little Oak, near Vacaville, in the rolling foothills at the edge of the Great Valley. He was graduated from the University of California in 1889. The following year he became an assistant in botany and devoted his attention principally to systematic botany under the direction E. L. Greene, pioneer taxonomist and founder of the Department of Botany. From 1895 to 1898 Jepson served as instructor, undertaking research with Greene, M. A. Howe, Setchell, and J. C. Merriam at Berkeley, G. F. Atkinson and W. W. Rowlee at Cornell (1895), and B. L. Robinson at Harvard (1896–97). He was awarded the Ph.D. at the University of California in 1899, with a major in systematic botany and minors in plant physiology and paleophytology. In 1905 he studied the classical herbaria at the Royal Botanic Gardens, Kew, and in 1906 those at Berlin. He was made assistant professor in 1899, associate professor in 1911, professor in 1918, and professor emeritus in 1937. Thus, his entire life was identified with the University, and his work devoted almost exclusively to the plants of California.

His botanical reputation must rest primarily on the ambitious *Flora of California*, which he regarded as his major contribution. This is perhaps the outstanding work on regional flora thus far produced in this country. It owes its great merit to the wealth of field observation, ecological and geographical data, profuse illustration, and careful documentation of observations and ranges by citation of specimens, as well as to the eminently sane taxonomic judgment. Although he was a student and admirer of Greene and incorporated much of that author's brilliant but frequently erratic work, Jepson's taxonomic concept was essentially conservative and in the tradition of Bentham, Hooker, Torrey, and Gray. Because of its general usability, his manual has long enjoyed a popularity in the West comparable only to that of "Gray's Manual" in eastern North America. Jepson's voluminous publications will necessarily serve as the basis for all future work on the rich California flora.

The editorship of *Erythea* was turned over to him by Greene, and he served in that capacity from 1893 to 1900. Jepson founded the California Botanical Society in 1915 as well as its journal, *Madroño*, which he edited until 1933. In these two journals appeared most of his shorter papers, dealing with botanical exploration and biography, geographical distribution, taxonomy, and teratology. His field work covered most of the state, and he was particularly fond of the less known deserts, mountains, and valleys, where he reveled in the role of pioneer explorer. In 1899 he made a botanical expedition to Alaska, and in 1926 to Syria and Palestine, but the bulk of his field study was confined to California. He was an enthusiastic conservationist and served as a councilor of the Save the Redwoods League and of the Point Lobos Association. Although he will be classified as an "orthodox" taxonomist, he was an ardent evolutionist and more hospitable than many of his contemporaries to the cytogenetic and experimental approaches of "biosystematics."

Many honors came to him during his long, productive lifetime. His colleagues honored him with the Faculty Research Lecturership in 1934, and his University with the LL.D. in 1941. He was president of the California Botanical Society, 1913–15 and 1918–29; fellow of the California Academy of Sciences, American Academy of Arts and Science (Boston), Royal Society of Arts (London), and American Geographical Society; delegate to the International Agricultural Congress at Liége (1906) and the International Botanical Congresses at Cambridge (1930) and Amsterdam (1935); foreign member of the Société Linnéenne de Lyon and the National Botanical Society of Czechoslovakia; councilor of the Rancho Santa Ana Botanical Garden; life member of the American Genetic Association; and member of the American Society of Plant Taxonomists, Botanical Society of America, Society of Foresters, Washington Academy of Sciences, Western Society of Naturalists, Phi Beta Kappa, and Sigma Xi.

His memory is perpetuated by the saxifragaceous genus, *Jepsonia*, dedicated to him by J. K. Small, and by a host of commemorative specific epithets. But these tokens are insignificant in comparison with the tremendous debt owed him by every student of Californian natural history. He was remarkably successful both as teacher and writer in communicating his great enthusiasm for the flora which he had done so much to make understandable. Perhaps he would prefer to be remembered, in the words of his memorial to Parish, "as one who cared for and gave his life without stint to botanical science, as one who believed in the science absolutely, as he conceived it."

LINCOLN CONSTANCE
University of California, Berkeley

NEWS *and Notes*

The secretaries of all societies planning to participate in the Chicago meeting of the AAAS next December have been sent a letter in which financial problems of the Association and its affiliated societies are outlined. It is estimated that the total expense of the meeting will be about $35,000 and the net deficit about $14,000, $7,000 of which will result from session room charges levied against the AAAS for the first time by the Chicago hotels. In the past deficits have been paid from AAAS reserves, but the Association no longer has these reserves. Consequently, it was requested that the executive committee of each cooperating society pass a resolution that, when meeting with the AAAS, attendance at sessions be restricted to those registering with the Association.

A number of facts concerning the financing of the AAAS meetings were pointed out: that the affiliated and associated societies do not contribute to the financial support of the Association in any way; that fewer than half of the persons who attend the meetings register, and most of those who register are AAAS members; and that local committees for meetings assume financial burdens of $4,000–$5,000 and contribute nearly as much again from their time.

Quoting further from the letter, "While one of the major aims of the AAAS is to facilitate cooperation among scientists, as it does through its meetings, the dues of 35,000 public-spirited members scarcely meet the present costs of operation and publishing its journals, let alone the needs of nonmember participants.... The payment of a registration fee of $2.00 or $3.00 represents only a small fraction of the total expenses of the average individual attending a convention, and it does not seem unreasonable to expect that meeting expenses be paid in part on a pro rata basis by those who benefit from the convention. If publication of the *General program* were the only service provided by the Association and the local committees, it would not be reasonable to ask members of societies that publish their own programs to register with the AAAS. However, the services are many and, as evidence of appreciation, the cooperative spirit of the local committees might well be reciprocated through the registration of all the conventioners. Both at Boston and Chicago the committee chairmen unanimously recommended that registration be made mandatory in order that the annual convention be placed on a sound financial basis. No other major meeting of scientists has as low a registration fee, and it is difficult to believe that payment of it would work a serious hardship on the members of the cooperating societies."

In a questionnaire the secretaries of those societies which met with the AAAS in Boston were asked if the registration fee should be made mandatory. Of those who replied, over two-thirds said "yes." The problem of increasing registration has been discussed in detail with society secretaries who have visited the Washington office, and all have agreed that general registration is essential to the support of the meetings.

The reactions to the letter were not as varied as anticipated, there being an almost unanimous expression favoring the registration of all conventioners. Typically some of the comments are as follows:

"I personally believe that: (1) registration should be required for attendance at any of the activities or meetings of the Association or affiliated societies; (2) the registration fee for nonmembers should be $8.00; and (3) that a nonmember, by joining the society, may register at the regular fee for members, namely, $5.00."

"Your moving letter of May 21 on Annual Meeting costs and registration fees has been carefully read. You put the situation in a somewhat different light than I have had and I would now retreat somewhat from my stand of a few months ago. You will remember I wrote you then in an unsympathetic vein about registration fees."

"In addition to a registration fee, a fee (should) be charged for the reception and for all smokers.... scientific sessions (should) be proctored and no one admitted who does not show evidence of having registered."

"I have at hand your memo of May 21st to Secretaries of the Societies meeting with the AAAS in Chicago. I think you are perfectly justified in bringing the question of finances to their attention, and I am completely in agreement with any policy of required registration."

"I am unable to understand the attitude of those who deliberately fail to register and at the same time are willing to avail themselves of the advantages of the meetings at the expense of others. I suspect and hope that a good deal of this neglect is due to thoughtlessness and failure to think of the implications of such an attitude. Even so, it is a significant criticism of the supposed capacity of scientists to carry over into the field of social relationships the kind of thinking which is alleged to be implicit in the scientific approach."

"I have your memo relative to expenses of meetings. I think the two dollar registration fee is all right, but I would be opposed to making it any more than this. I know that many people are a little bit restive about having to pay a fee at all, particularly if they only want to go to a couple of sessions. However, I believe it is very necessary and should be followed."

"The headache back of all of the endeavor is the fact that the Association is top heavy with affiliated societies which have their own annual meetings and which are the first love of the members.... I am all out for increasing the annual membership fee to $10.00. But I also incline to the view that the annual meeting should be self-liquidating."

"... it is the unanimous opinion of our Executive Committee that a mandatory registration fee should be charged at all AAAS meetings. A fee of two dollars might cover the costs if the fee is mandatory. If it will not cover the costs, the fee should be increased to three dollars."

So far, not one letter has been received in opposition to general registration. However, legislative machinery is slow moving and, in lieu of a final decision by the various executive committees, the administrative officers of the Association have adopted the following course of action: Each society meeting in the hotels in Chicago will pay the charges for the session rooms it uses. When all the operating costs of the convention have been met by the Association, any surplus from registration will be distributed on a proportional basis among the cooperating societies to help cover the costs assessed them for the use of session rooms.

The AAAS is a federation of scientific societies with no binding ties other than a desire to maintain a centralized organization, representative of all fields of science, that can speak for American science and, through inter-society cooperation, broaden the intellectual horizons of its members. The governing body of this federation is its Council, more than two-thirds of which is elected by the affiliated societies, and which, in turn, elects all general officers of the AAAS, including its Executive Committee. The policies and plans of the administrative officers of the AAAS are, therefore, those determined by the affiliated societies.

About People

Donald F. Jones, chief geneticist, Connecticut Agricultural Experiment Station, received the honorary degree of Doctor of Science from Kansas State College June 1, in recognition of his outstanding work in genetics and his origination of the method by which hybrid seed corn is produced commercially.

Louis N. Ridenour, formerly assistant professor of physics, University of Pennsylvania, has been appointed dean of the Graduate School, University of Illinois. During the war Dr. Ridenour directed the development of new types of radar at the Radiation Laboratory, Massachusetts Institute of Technology, and later served as special consultant to Gen. Carl A. Spaatz.

Colin G. Fink, professor of electrochemistry, Columbia University, has resigned his position as secretary and editor, Electrochemical Society, after 26 years of continuous service. Dr. Fink, now "secretary emeritus," is succeeded by R. M. Burns, chemical director, Bell Telephone Laboratories.

George B. Barbour, dean, College of Liberal Arts, University of Cincinnati, leaves this month for Johannesburg to join the University of California African expedition as geologist and physiographer. The group, under the leadership of Charles L. Camp, director of the Museum of Paleontology, will spend the early part of the field season excavating cave deposits of the type where fossil anthropoids closely related to primitive man have been found.

B. S. Pickett, head, Department of Horticulture, Iowa State College, will spend a year in Syria as horticultural adviser to the Syrian Government. Prof. Pickett, who has been granted a year's leave of absence, expects to plan and begin research work in fruit growing, promote better processing of Syrian fruits, and encourage government support of research and promotional work in fruit growing.

Willis E. Pequegnat, assistant professor, and head, Department of Zoology, Pomona College, has been promoted to associate professor.

Curt Stern, professor of zoology, and chairman, Department of Zoology, University of Rochester, has been appointed professor of zoology at the University of California, Berkeley. He will assume his duties there in the fall.

Frank Kerekes, professor, Department of Civil Engineering, Iowa State College Engineering Experiment Station, has been appointed assistant dean of the Division of Engineering. **J. D. Ryder,** Department of Electrical Engineering, has been appointed assistant director of the Engineering Experiment Station.

Frank T. Knapp, University of Toronto, has been appointed assistant in the Limnological Research Program, Cranbrook Institute of Science, Bloomfield Hills, Michigan.

E. Richard Dichter, consultant, Schenley Distilling Corporation, and formerly special assistant to the vice-president in charge of research and development, General Foods Corporation, has been appointed to the staff of Schering Corporation.

E. Lucy Braun, professor of plant ecology, University of Cincinnati Graduate School of Arts and Sciences, is leading a party of scientists from eastern United States and Canada into remote sections of the Kentucky mountains to study fast-disappearing virgin forest tracts there. The 5-day field expedition, centering near Pineville, in southeastern Kentucky, and sponsored by the Ecological Society of America, started June 9 from Clear Creek, Kentucky, for daily excursions to Kentucky Ridge Forest on Pine and Log Mountains, Natural Bridge, and the Red River Gorge.

Herbert E. Wright, Jr., Brown University, has been appointed assistant professor of geomorphology, Department of Geology, University of Minnesota. Dr. Wright will assume his new duties there in September.

Forrest F. Cleveland, chairman, Department of Physics and Mathematics, Lynchburg College, Lynchburg, Virginia, will be visiting professor of physics at Ohio State University during the summer semester, and will return in September to his former position as professor of physics, Illinois Institute of Technology, Chicago.

Henricus J. Stander, professor and head, Department of Obstetrics and Gynecology, New York Hospital, will receive the degree of Doctor in Medicine, *honoris causa*, from Trinity College, Dublin, Eire, at the Commencement Exercises of the College on July 2. While in Dublin, Dr. Stander will speak at the International Congress of Obstetricians and Gynecologists, to be held July 7–11.

Visitors to U. S.

Sir Edward Mellanby, secretary-director of the British Medical Research Council, who recently completed a visiting lectureship appointment at Vanderbilt University, spoke at the auditorium of the Children's Fund of Michigan, Detroit, on May 7 and at the Yale University Medical School on May 19 on "Nutrition in Relation to Bone Growth and the Nervous System." Sir Edward and Mrs. Mellanby took passage for England shortly thereafter.

Georg v. Békésy has been granted leave of absence by the Pázmány Péter University, Budapest, to spend a year on the staff of the Psycho-Acoustic Laboratory, Harvard University. Prof. Békésy is internationally known for his work in physiological acoustics, especially his investigations of the dynamics of the auditory mechanism.

Douglas H. K. Lee, professor of physiology, University of Queensland, Brisbane, Australia, will be in Washington, D. C., from June through September making a survey of animal climatology with Ralph W. Phillips for the UN's Food and Agriculture Organization. On October 1 Dr. Lee will join the staff at Johns Hopkins University, Baltimore, where he will spend four months working on human climatology.

Jacques Maton, who recently received his doctorate from the University of Ghent, is studying phases of plant nutrition at the University of California, Berkeley, on a Belgian-American Research Foundation fellowship.

Grants and Awards

The Association for the Study of Internal Secretions has recently announced the following awards: the Squibb Award for 1947, to Carl F. and Gerty T. Cori, Washington University, St. Louis, for their outstanding contributions on the role of the hormones in metabolism; the Ciba Award, to Choh Hao Li, University of California, for his significant contributions in the separation and study of hormones of protein nature and the isolation of the growth and adrenocorticotropic hormones in homogeneous and highly purified form; the Ayerst, McKenna and Harrison Fellowship, to Samuel Dvoskin, Columbia University, to enable him to continue his studies on the thyroid gland and thyroid hormone assays at Columbia under the direction of Robert Loeb.

Syracuse University has announced the establishment of two fellowships in organic chemistry by the Bristol Laboratories, Inc. The two Bristol Fellows recently appointed are John L. Biester and Robert C. Scott, who are working toward the Ph.D. degree under the direction of P. M. Ruoff, associate professor of chemistry.

Colleges and Universities

Carnegie Institute of Technology has received additional financial support for its 200,000,000-volt synchrocyclotron project in the form of a contract from the U. S. Office of Naval Research and an offer of equipment at special prices from the Westinghouse Electric Corporation. The total value of these two contributions is $280,000, or enough to fulfill the conditions of the $300,000 appropriation received by Carnegie Tech from the Buhl Foundation of Pittsburgh last December. The Foundation stipulated that its grant be supplemented by subscription of at least $250,000 toward the cyclotron from other sources.

Robert E. Doherty, president of the Carnegie Institute, expressed the hope that between $350,000 and $420,000 more may be raised so that Carnegie may build a synchrocyclotron having 130-inch magnet poles, instead of the 110-inch size projected last year. Total cost of the larger machine may reach $1,000,000.

Yale University has established the Ross Granville Harrison professorship in experimental zoology, named in honor of Ross G. Harrison, professor emeritus, who joined the Yale faculty in 1907, according to an announcement by President Charles Seymour. Edgar J. Boell, professor of biology, has been appointed the first incumbent of the new chair. The appointment is effective July 1.

Elections

The Iowa Academy of Science, at its 59th annual meeting in Cedar Falls, Iowa, April 18–19, elected the following officers: J. Allen Baker, president; William Kadesch, vice-president; F. G. Brooks, editor; and Cornelius Gouwens, secretary-treasurer.

Nine sections of the Academy held sessions which were attended by about 350 and during which 101 papers were presented. A joint symposium was held with the Iowa Medical Society. The guest speaker of the Academy, A. C. Trowbridge, gave an address on "A Geological Expedition to Norway."

The Association of American Physicians, at the closing session of its 60th annual meeting, Atlantic City, May 7, elected the following officers for the coming year: A. H. Gordon, Montreal, president; Francis G. Blake, New Haven, Connecticut, vice-president; Walter Bauer, Boston, treasurer; Cecil J. Watson, Minneapolis, recorder; Henry M. Thomas, Jr., Baltimore, secretary; and Joseph T. Wearn, Cleveland, Ohio, councilor.

The American Oil Chemists' Society, at its 38th annual meeting in New Orleans, May 22, elected the following officers: Reid T. Milner, Northern Regional Research Laboratory, president; C. P. Long, Proctor and Gamble, first vice-president; E. M. James, Lever Brothers Company, second vice-president; V. C. Mehlenbacher, Swift and Company, third vice-president; L. B. Parsons, Lever Brothers Company, fourth vice-president in charge of the soap section of the Society; H. L. Roschen, Swift and Company, secretary; and J. J. Vollertson, Armour and Company, treasurer.

The New York State Geological Association, at its meeting in New York City, May 9, elected the following officers for the coming year: Nelson C. Dale, Hamilton College, president; and Robert H. Arndt, Hamilton College, secretary.

NRC News

The Prevention of Deterioration Center, Room 204, National Research Council, 2101 Constitution Avenue, N.W., Washington, D. C., now offers the "Prevention of Deterioration Abstracts" on a yearly subscription basis. The Abstracts are set up under the following headings: Electrical and electronic equipment; Finished assemblies; Fungicides; Lacquers, paints, and varnishes; Leather; Lubricants; Metals; Microorganisms; Optical instruments; Packaging; Paper; Plastics, resins, rubbers, and waxes; Storage; Textiles; and Wood. Abstracted items include journal articles, patents, specifications, unpublished reports prepared by various Army, Navy, and other governmental groups, and unpublished British, Australian, and Canadian reports.

There will be approximately 1,500 pages of the Abstracts per year. The individual Abstracts are in loose-leaf form, so that they may be arranged in the manner desired. However, all Abstracts classified under any one heading will be numbered consecutively throughout the calendar year.

The Abstracts may also include comments made by the personnel of the Prevention of Deterioration Center. The price, including two binders and index guides, is $37.50 per year (July 1–June 30). Back issues for 1946 will be supplied.

The Subcommittee on Ophthalmology, Division of Medical Sciences, met in executive session in Chicago on April 27. The meeting was devoted to a discussion of ophthalmological problems encountered in the military services. The Subcommittee is also taking an active interest in the establishment of a national institution for the training and rehabilitation of the blind, fashioned after the famous St. Dunstan's School in England. A proposal has been made by the Subcommittee that the Federal Government take over the facilities of the Army's rehabilitation center at Avon, Connecticut, where outstanding work has been done with those blinded in the war.

The Subcommittee includes the following members: Alan C. Woods, chairman; Edwin Dunphy, Trygve Gundersen, Lawrence Post, Algernon B. Reese, and Derrick T. Vail.

Recent Deaths

E. Granville Crabtree, 65, urologist, New England Baptist Hospital and Beth Israel Hospital, died in Sharon, Vermont, May 30. Dr. Crabtree was president-elect of the American Urological Association.

Walter T. Garfield, 65, dermatologist and professor emeritus, Tufts College Medical School, died May 31 at the Boston City Hospital after a brief illness.

Charles A. Kofoid, 81, professor emeritus of zoology, and formerly chairman, Department of Zoology, University of California, Berkeley, died May 30.

Walter J. Crocker, 61, former professor of pathology and bacteriology at the Veterinary School, University of Pennsylvania, died May 14, in Philadelphia.

H. E. Wells, 73, professor emeritus of chemistry at Smith College, died May 24 in Hartford, Connecticut.

G. A. Millikan, 41, head of the Department of Physiology, Vanderbilt University, died May 26 in Spencer Tennessee, as a result of injuries received on a mountain-climbing trip.

Thomas T. Read, 67, Vinton professor emeritus of mining engineering, Columbia University School of Mines, died of a heart ailment at the White Plains Hospital, New York, May 29.

The reprint collection of the late S. O. Mast is available for donation, The collection consists of some 15,000 separates, mostly in the field of general physiology and covering the past 50 years. Since the collection is especially rich in papers in invertebrate behavior and protozoan physiology, it would be appropriate to make it available to the library of an institution or department specializing in such work, and particularly to one in a devastated European center. Donation to an individual will not be considered. Suggestions for the disposal of this collection will be gratefully received by Dr. John B. Buck, National Institute of Health, Bethesda 14, Maryland.

The California-at-Davis Chapter of Sigma Xi was installed on the Davis campus of the University of California May 10. Carl D. Anderson, president-elect of the National Society, was the installing officer. Officers of the new Chapter for 1947–1948 are: Tracy I. Storer, president; Coit A. Suneson, vice-president; and Harold G. Reiber, secretary.

The University of Pennsylvania Press intends to publish in the near future an annual, *Chymia*, each volume of which will consist of about a dozen articles in the field of the history of chemistry. Papers on a variety of subjects will be included, and publication may be in French, German, Spanish, Portuguese, Italian, and English. This publication, which is being sponsored by the Edgar F. Smith Memorial Collection at the University, will be under the direction of a board of American editors, with a large group of consulting editors of international prominence. Further information may be obtained from Eva V. Armstrong, Secretary of the Board of Editors, Edgar F. Smith Collection, Harrison Laboratory, University of Pennsylvania, Philadelphia 4.

The National Registry of Rare Chemicals, Armour Research Foundation, 35 West 33rd Street, Chicago 16, Illinois, lists the following wanted chemicals: trimethyl aluminum, cholinesterase, decamethylenediamine, 1,2,3,4,5,6-hexachlorocyclohexylpentachloroethane, p-(β-dimethylaminoethyl)phenol, methylphenylbarbituric acid, 3,4-dihydroxynorephedrine, stevioside, creatine phosphate, hexacosane, phenyldimethylphosphine, citronellic acid, cellotetraose, glyoxylic acid, corynanthine, dihydromyrcene, kephalin, d-quercitol, quebrachitol, and indoxyl potassium sulfate.

The Medicinal Division, American Chemical Society, will publish its first monograph early next year. The monograph will be a complete progress report on world-wide advances in medicinal research. C. M. Suter, associate research director, Sterling-Winthrop Research Institute, Rensselaer, New York, has been appointed editor-in-chief. Dr. Suter will be assisted by the following editorial board: Walter H. Hartung, professor of pharmaceutical chemistry, School of Pharmacy, University of Maryland, Baltimore; Richard Roblin, director of chemotherapeutic research, American Cyanamid Company, Stamford, Connecticut; Peter K. Knoefek, professor of pharmacology, University of Kentucky School of Medicine, Louisville; Edward F. Degering, professor of organic chemistry, Purdue University, Lafayette, Indiana; Maurice L. Moore, assistant director of research, Frederick Stearns & Company Division, Sterling Drug, Inc., and chairman of the Medicinal, Division (*ex officio*); and L. A. Sweet, Parke, Davis & Company, secretary of the Medicinal Division (*ex officio*).

The Chicago Natural History Museum has announced the following appointments: Emmet R. Blake, associate curator of birds; Loren P. Woods, curator of fishes; John W. Winn, assistant curator of fishes; and John W. Moyer, chief of the new motion-picture division of the Museum.

Make Plans for—

Meteoritical Society, 10th meeting, June 18–19, San Diego, California.

American Association of Physics Teachers, June 18–21, University of Minnesota, Minneapolis.

American Physical Society, June 19–21, Montreal, Canada.

American Society of Agricultural Engineers, June 22–25, Philadelphia, Pennsylvania.

American Society for X-Ray and Electron Diffraction, June 23–25, Montreal, Canada.

American Association of Dental Schools, June 23–25, Chicago, Illinois.

American Dairy Science Association, June 24–26, Ontario, Canada.

COMMENTS *by Readers*

Ever since Boveri discovered that the large end segments of the chromosomes of *Ascaris* are discarded in the somatic cell lineage while the chromosomes remain intact in the germ track, the phenomenon, chromatin diminution, has attracted the attention of cytologists. Chromatin diminution has since been found to occur in other nematodes and in Diptera (Cecidomyids, Sciara), the cytological details being different from case to case. Among the numerous explanations proposed (most recent one by von Ubisch), that most in line with modern conceptions is that the diminished chromosome parts must be "inert so far as the soma is concerned" (White).

A re-examination of the cytological facts, using the Feulgen technique, proves beyond doubt that the discarded chromosome ends consist of heterochromatin. The decisive fact is that this substance is condensed during synapsis into a large, deeply staining chromocenter which fills a considerable part of the nucleus and to which the chromatin strands are attached. In pachytene this chromocenter is broken up and again distributed as four heteropycnotic ends of the tetrads. Boveri's old figures show, though it could not be interpreted correctly at that time, that there is also heteropycnosis of the chromosome ends in telophase of the first division of the egg. The Feulgen technique confirms this in a most convincing manner. Later, at the time of diminution, the Feulgen stain reveals in early metaphase that almost all Feulgen positive material is accumulated in the chromosome ends to be discarded, while the middle parts of the collective chromosomes which break up into the small somatic chromosomes stain rather slightly. Thus, there can be no doubt of the heterochromatic nature of the diminution chromatin.

This fact allows us to advance an hypothesis on the meaning of diminution which is in accord with some modern views on heterochromatin (e.g. Darlington). Nematodes are cell-constant animals, as shown a long time ago by Goldschmidt, Jägerskjöld, and Martini. This means that somatic cells undergo only a small number of divisions, after which further growth is intracellular growth leading to a small number of giant cells in most organs. Only the sex cells retain the ability for almost unlimited division. This means, we think, that the heterochromatin is needed for continuous mitotic cell division. A detailed discussion including also the situation in Diptera, and the relation of the cytological facts to the genetics of heterochromatin, will be presented later with the detailed facts. (Richard B. Goldschmidt and Teh Ping Lin, *Department of Zoology, University of California, Berkeley.*)

* * *

It was demonstrated by Guerra (*Science*, June 7, 1946, p. 686) that the activity of hyaluronidase *in vivo*, as measured by the area of spreading when injected into the skin of rabbits or human subjects, is inhibited by salicylate. However, when the activity of the enzyme was measured *in vitro* by the decrease of the viscosity of its substrate, hyaluronic acid, no inhibition was observed when salicylate was added to the system. This is in accord with the observation of Pike (*Science*, April 11, p. 391).

It was therefore concluded that the action of the salicylate might be due to a metabolite formed by the organism.

Gentisic acid (2.5-dihydroxybenzoic acid), which has been demonstrated by Kapp and Coburn to be a metabolite of salicylic acid (*J. biol. Chem.*, 1942, 145, 549), shows no inhibition. However, the corresponding carboxy-p-benzoquinone, which was synthetized by us, shows strong inhibitory properties at a concentration of 2.5×10^{-4} M. A detailed report of this work will be published elsewhere. (Julius Lowenthal and Arthur Gagnon, *Department of Physiological Chemistry, University of Montreal.*)

* * *

That anurans may lay as few as one egg per season is well known (Noble *Biol. Amphib.*, 1931, 70; *Sminthillus* of Cuba), but the maximum number has been diversely stated.

The maximum produced by North American anurans is recorded by Dickerson (*Frog Book*, 1908, 3) as 12,000 (*Bufo americanus*), and by Wright and Wright (*Handb. Frogs Toads*, 1942, 8) as 20,000 (*Rana catesbiana*). These numbers are exceeded, however, in at least three North American species of toads: one *Bufo a. americanus* is known to have laid 20,309 eggs, and one *B. w. woodhousii* 25,644 (Smith *Amer. mid. Nat.*, 1934, 15, 438, 452); and, as pointed out by Gadow (*Amphibia Reptiles*, 1923, 54), even these figures are exceeded by *B. americanus terrestris*, a specimen of which is recorded (Morgan. *Amer. Nat.*, 1891, 25, 753) to have laid as many as 28,000.

The bullfrog itself is recorded by Cramer (*Bull. Fla. St. Dept. Agric.*, 1936, No. 56, 37) as laying at least 21,840 eggs (this number of tadpoles was hatched from one spawn). In Viosca's *Principles of bullfrog culture* (New Orleans: Southern Biological Supply Co., 1934) the eggs are said to number as many as 25,000, a figure also given in the Fish and Wildlife Service's pamphlet on "Frog culture and the frog industry" (Fishery Leaflet No. 102, 1944. 3).

It is not unreasonable to suppose that very large specimens of at least one of these species may lay as many as 30,000, which may be accepted as the maximum for anurans of North America (except possibly *B. horribilis*).

Even this number is known to be exceeded elsewhere by *B. marinus* (tropical America; a close relative of *B. horribilis*), which, according to Alipio de Miranda-Ribeiro (*Arch. Mus. Nac. Rio de Janeiro*, 1926, 27, 134), produces approximately 32,000 at each spawning. No doubt this species may produce as many as 35,000 upon occasion. So far as I am aware no amphibian anywhere in the world is known to lay more than this number at one time.

It is also of interest to point out that, in proportion to body size, members of the genus *Bufo* are clearly more productive of eggs than any other anurans. (Hobart M. Smith, *A. & M. College of Texas, College Station, Texas.*)

* * *

TECHNICAL PAPERS

Development of Streptomycin-resistant Variants of Meningococcus[1]

C. Phillip Miller and Marjorie Bohnhoff

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In an attempt to explain the rapidity with which meningococci develop a very high degree of streptomycin resistance during two or three subcultivations on media containing increasing concentrations of the drug (*6*), the following observations were made.

A series of plates was prepared containing streptomycin[2] in graded concentrations from 10 to several thousand µg./ml. of media, and the surface of each was inoculated with a heavy seeding of meningococci. The inocula were carefully spread by means of small glass beads which were rolled back and forth and discarded after the inocula were evenly distributed. The plates were examined at the end of 24, 48, and 72 hours incubation. The results of a typical experiment are presented diagrammatically in Fig. 1.

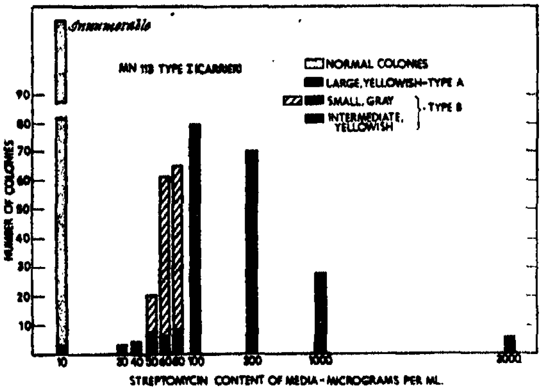

FIG. 1. Diagrammatic representation of colonies developing from equivalent inocula of meningococci on graded concentrations of streptomycin. Density in cross-hatching indicates differences in size and color of Type B colonies.

Normal meningococcus colonies developed on the lowest concentrations of streptomycin (10–20 µg./ml.) but were lacking on concentrations above 40 µg./ml. On concentrations higher than that, two types of colonies unlike the normal were observed. These have been designated variants A and B. Their properties are summarized in Table 1.

Both variants have developed from 16 of 18 strains of meningococcus and on all of 25 preparations of streptomycin, including several of a high degree of purity.

The type A variant appears in approximately equal numbers on all concentrations of the drug, but the numbers of colonies per plate vary considerably from strain to strain. It seems highly probable, therefore, that this type of colony arises from streptomycin-resistant mutants which are appearing regularly in the original bacterial population.[3] This variant differs from the original culture in size and color of colony and in being streptomycin resistant *in vitro* and *in vivo*. It multiplies on any medium which supports growth of normal meningococci. It is as virulent for mice as the original culture from which it arose, and produces infection against which maximal doses of streptomycin afford no protection.

TABLE 1

SUMMARY OF CHARACTERISTICS OF MENINGOCOCCUS VARIANTS A AND B

	Type A	Type B
Colonial appearance		
Size	Large on all concentrations of streptomycin	Small on low concentrations; medium on higher concentrations
Color	Yellowish	Pearl gray on low concentrations; slightly yellowish on higher concentrations
Viability on all concentrations of streptomycin	Grows readily	Grows readily on concentrations above 5 µg.ml.
Viability on streptomycin-free media	Grows readily	No growth*
Virulence for mice	Fully virulent	Nonvirulent except in streptomycin-treated mice
Effect of streptomycin treatment on experimental infection in mice	No protection from maximal doses	Promotes development of fatal meningococcal sepsis

* *Among many subcultures onto streptomycin-free media only 4 single* colonies grew out slowly.

Variants presumably of the same sort have been described by Alexander and Leidy (*1*) from *Hemophilus influenzae* and by Chandler and Schoenbach (*5*) from other microorganisms.

Colonies of the type B variant have one characteristic in common: They all require streptomycin for reproduction *in vitro* and *in vivo*. This variant is not virulent for mice; *i.e.* intraperitoneal inoculations with mucin suspensions (*7*) failed to produce meningococcal infection. However, mice thus inoculated and treated with adequate doses of streptomycin (500–5,000 µg.) developed fatal meningococcal sepsis. Meningococci could be recovered regularly from their hearts' blood in cultures made on streptomycin-containing media but not in duplicate cultures made on streptomycin-free media.

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[1] This investigation was supported jointly by the U. S. Navy, Office of Naval Research, and the University of Chicago. It also received assistance from the Antibiotic Study Section, Research Grants Division, U. S. Public Health Service, and from the A. B. Kuppenheimer Foundation of the University of Chicago.

A preliminary report of the study was presented at the Conference on Antibiotic Research held at Washington, D. C., on February 1, 1947 under the auspices of the Antibiotics Study Section, National Institute of Health.

[2] Preparations of streptomycin were supplied by the Antibiotics Study Section, National Institute of Health, U. S. Public Health Service; the Division of Penicillin Control and Immunology, Food and Drug Administration; Abbott Laboraties; Eli Lilly & Company; Merck & Company; Chas. Pfizer & Company; and E. R. Squibb & Son.

[3] The authors are indebted to Sewall Wright and Thomas Park, Department of Zoology, University of Chicago, for their helpful suggestions and criticisms of the genetic aspects of this problem.

The results of these mouse inoculations indicate that (1) the type B variants are nonvirulent for (untreated) mice; (2) they require streptomycin for their reproduction *in vivo* as well as *in vitro*; and (3) their dependence on streptomycin for growth persists after multiplication within the body of an infected animal host.

The origin of the type B variant is difficult to explain except as current mutation. It never appeared on media containing less than 40 µg./ml., but once it had developed, it could be subcultured on concentrations as low as 5 µg./ml. It could not be grown on less even after repeated transfer on media containing that concentration. The rare occurrence of a single colony on streptomycin-free media represents an exception to the rule and seems most likely to be the result of mutation back to normal.

The numbers of colonies developing from equivalent inocula are always greatest on concentrations between 100 and 400 µg./ml., whether the seedings are made from a parent (stock) strain, as illustrated in Fig. 1, or from a subculture of type B variant taken from a high or a low concentration of streptomycin. This fact seems to indicate that all the B variants are alike genetically and that the higher reproductive rate at those concentrations reflects a physiological response to the drug rather than a differential induction of the variants at different concentrations.

The variation in color and size of their colonies in relation to the concentration of the drug is additional evidence that streptomycin directly affects the physiology of the bacterial cells. On 60–100 µg./ml. they are small and pearl gray. On higher concentrations, they develop greater size and acquire a distinctly yellowish tinge, resembling the large variants described as type A. Small, gray colonies taken from low concentrations and transferred onto higher concentrations grow as medium-sized, pigmented colonies. Conversely, pigmented colonies taken from high and subcultured onto low concentrations develop as small gray colonies.

Benham (*4*) has noted the stimulating action of streptomycin on the O_2 uptake of typhoid bacilli. Welch, Price, and Randall (*9*) report that small doses of streptomycin increased the mortality rate of mice infected with typhoid bacilli.

Studies on the growth requirements of mutants isolated from cultures of *Bacillus coli* after treatment with bacteriophage (*2*) or X-ray (*8*) have demonstrated a variety of deficiencies in their metabolic processes. Similar observations have been made on mutants induced in *Neurospora* by X-ray (*3*).

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Irritating Effects of 9,9-Dibromofluorene

John R. Sampey, Anne B. King,
Thomas A. Roe, Jr., and S. J. Childress[1]

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Alfred Cavendish (*1*) has reported the irritating effects of 9-bromofluorene. In the further study of the photochemical bromination of fluorene (*2*), one of us (A. B. K.) worked several weeks with 9-bromofluorene without any irritation, but on the first exposure to 9,9-dibromofluorene, a severe skin eruption developed.

The irritation set in shortly after crystallization of a sample of 9,9-dibromofluorene from hot glacial acetic acid. Red blotches appeared first on the back of the left hand and the inner left wrist, and after a few hours red streaks developed on the face and ear. The rash spread gradually, and after three weeks it covered both forearms and face completely, and one eye was swollen shut.

Administration of benadryl relieved the severe itching at once, and within a few days the face peeled, and the blotches on the hands and arms began to dry up. Six weeks from the time of exposure, small red blotches remain only at the points of initial contact.

A second member of the group suffered some inflammation and itching of the hands following one exposure to 9,9-dibromofluorene, but the condition cleared up within a week, without medical attention.

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dl-α-Amino-ϵ-Hydroxy Caproic Acid in the Rat

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Laval University, Quebec, Canada

In the course of the synthesis of lysine from dihydropyran, one of the authors (R. Gaudry) prepared dl-α-amino-ϵ-hydroxy caproic acid by hydrolysis of 5-δ-hydroxy butyl hydantoin. Since this amino acid differs from lysine only because of its hydroxyl group instead of the ϵ-amino group, it was thought of interest to investigate its biological properties.

Young albino rats averaging 66 grams in weight were first placed on a diet of the following percentage composition: zein, 10; dl-tryptophane, 0.2; cellu-flour, 2; soybean oil, 4; salt mixture, 4; sucrose, 79.65; choline chloride, 0.15. Each 100 grams of ration contained: thiamine-HCl, 0.4; riboflavin, 0.4; pyridoxine-HCl, 0.5; calcium pantothenate, 3.0; nicotinic acid, 3.0; inositol, 10.0; and 2-methyl-1,4-naphthoquinone, 0.1 mg.

After 24 days on this diet, weight changes were very small (Table 1), and the following additions were made to the ration at the expense of the sucrose: Group I (Zt), 0.6 per cent zein; Group II (Ztl), 0.6 per cent l-lysine; and Group III (Ztl-OH), 1.5 per cent dl-α-amino-ϵ-hydroxy caproic acid. Eleven days

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[1] Acknowledgment is made of a grant from the Carnegie Foundation for the Advancement of Teaching.

later, the rats on the lysine-deficient ration had shown a slight weight loss, while those receiving l-lysine were gaining weight. The largest weight losses were recorded by the rats receiving the synthetic racemic compound (Table 1). One of the rats in this group died on the 11th day, and the experiment was discontinued. The animals were sacrificed and the kidneys were dissected and weighed. Kidneys of rats receiving the α-amino-ε-hydroxy caproic acid were slightly heavier, but histological examination[1] failed to reveal any differences between groups.

TABLE 1

WEIGHT CHANGES (GRAMS) IN RATS RECEIVING α-AMINO-ε-HYDROXY CAPROIC ACID AND IN CONTROL GROUPS

	Zt	Ztl	Ztl-OH
No. of rats per group	4	6	6
Wt. changes during last 10 days of preliminary period (24 days)	−4	−3	−2
Range	−3, −6	−1, −4	−2, −3
Wt. changes during experimental period (11 days)	−2	+5	−8
Range	−1, −3	+2, +9	−6, −10

It is concluded that α-amino-ε-hydroxy caproic acid cannot replace lysine in the diet and that it may have some toxic effect.

Mechanism of Renin Tachyphylaxis—Restoration of Responsiveness by Tetraethyl Ammonium Ion

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The pressor responses to repeated intravenous injections of renin in intact animals diminish progressively. This phenomenon is known as tachyphylaxis. The action of renin is dependent on the presence of plasma renin-substrate, the exhaustion of which might account for tachyphylaxis. But administration of large amounts of α_2 globulin, the fraction of plasma protein containing substrate, does restore the response in tachyphylactic animals (*6*).

Renin through its effector agent, angiotonin, acts directly on peripheral blood vessels. Nevertheless, sectioning of the brain at certain levels causes the pressor response to be reversed to depressor (*3*), a phenomenon which has been further localized by Euler and Sjöstrand (*2*). Widespread direct injury to the central nervous system also temporarily abolishes the pressor response to angiotonin (*4*), as does severe shock produced by a variety of means (*5*). Thus, the nervous system influences vascular responsiveness to angiotonin.

One of the difficulties of accepting the renal-vasopressor system as a cause of renal hypertension has been the phenomenon of renin tachyphylaxis.

Acheson and Pereira have shown that injection of tetraethyl ammonium chloride (*1*) blocks sympathetic ganglia. We have found that repeated (1–4 times) intravenous injections of 100 mg. into normal dogs anesthetized with pentobarbital completely overcame tachyphylaxis induced by repeated injection of renin. The response to angiotonin itself was also augmented. Even more striking was the manyfold increase in the response to adrenalin at a time when the response to nicotine was wholly abolished. The responses to histamine, mecholyl, and barium chloride were usually also augmented. Without anesthesia the same phenomena occur, but to a lesser degree. Adrenalectomy or nephrectomy in brief experiments did not alter these responses.

If the caudal spinal cord was destroyed after section at C_8 and the animal tested the next day after complete recovery from anesthesia, the responses to renin were augmented. Further, 8 injections of renin did not lead to appreciable tachyphylaxis. Administration of tetraethyl ammonium ion now did not further augment the already large response.

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Absence of a Macrocytic Anemia in Dogs Fed Choline or Choline Plus Fat

M. F. CLARKSON and C. H. BEST

Banting and Best Department of Medical Research, University of Toronto, Canada

Several groups of investigators in this university have been interested in choline since this substance was established as a dietary factor by the work of Best and Huntsman (*1*). While no detailed study of the effect of choline on the blood picture had been made here, a number of hemoglobin and red cell estimations in dogs fed large amounts of choline had failed to reveal any signs of anemia. A series of papers by Davis (*2*), in which it was reported that the administration of choline or choline plus fat produced in dogs a macrocytic anemia, came, therefore, as a surprise. An additional stimulus to the investigation of Davis' claims was provided by the fact that choline or its precursor, methionine, is now being used in many clinics in an effort to determine its role in the prevention of fat deposition or cirrhotic changes in the liver of patients.

A series of four normal male dogs was carefully observed by one of us (M. F. C.), and after the somewhat extended period necessary to obtain satisfactorily constant basal values for the red cell counts and the hemoglobin levels, choline or choline plus fat was added to the stock diet of the animals, which consisted of Canada Packers Frozen Dog Chum, sucrose, and bone meal. Dried yeast and cod-liver oil were provided twice each week and tomato juice once a week. All four dogs were on this diet for at least three months before the feeding of choline or choline plus fat. During this period they all gained weight, and their coats improved in texture.

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[1] Kindly done by C. Auger, of the Pathology Department.

For two of the dogs 10 mg. of choline/kg. of body weight and 60 grams of lard were added to the stock diet. The daily ration was fed at one meal, and the choline was incorporated in the center of a small portion of meat and offered to the dogs before the balance of the meal was given. In this way it was made certain that the dogs ingested all of the choline offered. Both animals ate their fatty meals well for the first week and then refused to eat all of the food. The fat and choline were discontinued after the eighth day. Davis reports an anemia on the second and third day under these dietary conditions.

For the second pair of dogs the daily ration of the stock diet was divided into three equal feedings, and with each feeding 10 mg. of choline/kg. of body weight was administered in the same manner as previously described.

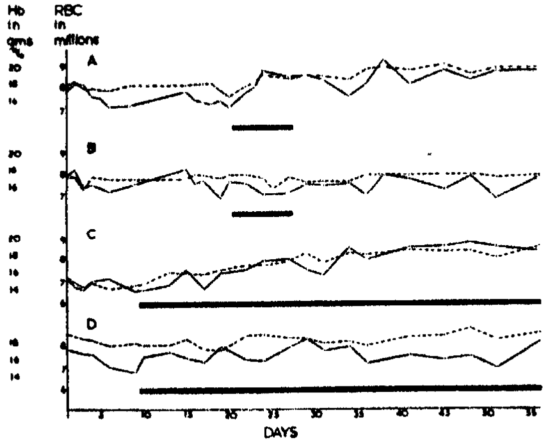

FIG. 1. Red cell counts and hemoglobin levels as influenced by choline or choline plus fat feedings. Solid lines represent red cell counts; broken lines, hemoglobin level; and solid black bars, the periods of choline or choline plus fat feeding. A and B were fed choline plus fat; C and D were fed choline three times a day.

The findings are illustrated in Fig. 1. It will be observed that we failed completely to confirm Davis' finding that a macrocytic anemia is produced in dogs when choline or choline plus fat is administered. In two dogs, A and C, there was an increase in the hemoglobin level and in the erythrocyte number. We do not ascribe this increase to the choline or choline plus fat, but strongly suspect that the rise is produced by a continued administration to the animals of a diet more adequate in the various hemopoietic factors than that which they had previously received. If Davis' results are confirmed under dietary conditions differing from those followed in our laboratory, the nature of the stock diet should be closely examined to determine the part it plays in the production of the findings. As estimated in this laboratory, Purina Dog Chow Checkers, of which Davis' stock diet is composed, contains 1.5 mg. choline/gram, and the Canada Packers Frozen Dog Chum contains 1.04 mg./gram. Our dogs received in the stock diet approximately 429 mg. of choline daily. We have found that they will not eat more than 180 grams of the Purina Chow daily. Consequently, they may have received about 160 mg. more choline/day in their stock diets than Davis' dogs.

In another group of four normal male dogs 10 mg. of choline/kg. of body weight was fed in dilute solution by stomach tube once a day, before the stock diet supplemented with 60 grams of lard was offered. During the eight days of the experiment there was no evidence of a macrocytic anemia.

An analysis of nurses' diets used in one of the large hospitals in Toronto showed that up to 500 mg. of choline may be available in a normal diet each day. This amount is presumably supplemented by choline arising from its precursor, methionine, which is supplied by the protein of the diet. There is, of course, no indication that normal diets, most of which provide appreciable amounts of choline, play any role in the production of an anemia.

Our results permit us to state quite definitely that, under the conditions of our experiment, the addition to stock diets of the amounts of choline or choline plus fat recommended by Davis does not produce in dogs any trace of a macrocytic anemia. It is apparent, therefore, that the acceptance of Davis' general conclusions cannot be justified and that further work is necessary to determine the explanation of his findings.

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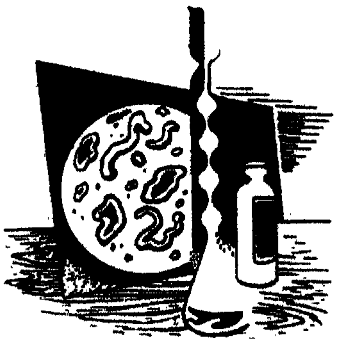

IN THE LABORATORY

An Automatic Recording Siphon

E. William Ligon, Jr.

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Washington, D. C.

An experimental study (*1*) required simultaneous records of intralumen pressures in, and flow through, Thiry-Vella loops in dogs. The pressures were recorded photokymographically, using modified Frank capsules as tambours, and flow was similarly recorded by means of the automatic siphon devised by the author for this purpose.

Since the use of optical manometers is rapidly gaining favor among investigators interested in studies involving accurate measurement of pressures and flow, it is felt that a brief description of this siphon may be helpful.

The siphon (Fig. 1) is constructed of pyrex glass, utilizing a test tube of convenient size and sections of tubing and reinforcing rod, and can be readily made by anyone able to weld pyrex tubing.

The fluid to be measured enters the receiving chamber, B, at A and continues to fill the system until the level reaches f, when the fluid escapes through the siphon arm, C. The system empties until the fluid level reaches e and air enters the siphon arm. With the fluid level at e, the side chamber, D, is connected by rubber tubing to an optical manometer. Subsequent additions of fluid to B cause increased pressure in D which is transmitted to a sensitive manometer and recorded photokymographically in such a way as to give a rising line which falls suddenly each time the siphon empties. Rate of flow is shown by the slope of the line at any point, and total flow is indicated by the change in height between any two points (plus the volume of the siphon multiplied by the number of times it has emptied in the meantime). The manometer can be accurately calibrated by adding known increments of fluid to B and taking short strips of record. The size of chamber B can be adjusted to the investigator's needs. The size of chamber D should be such that there is little variation in the level of fluid. The internal diameter of the siphon tube, C, however, is critical. If it is too great, there is a tendency for fluid to spill over without emptying the system; if it is too small, a column of air bubbles and fluid is retained in the right-hand limb, and the system empties *before* fluid reaches level f. With water, the best operation was obtained with a siphon arm 5–6 mm. in internal diameter. In addition, the siphon arm empties itself more efficiently if one end of a small string is tied to one of the upper supporting rods and the other end passed into chamber B and out through the siphon arm, its function being to aid in preventing retention of bubbles in the siphon arm after each emptying of chamber B.

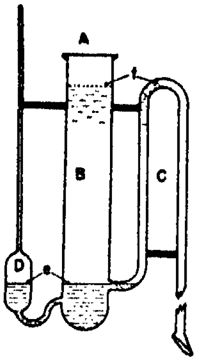

Fig. 1

Reference

1. Ligon, E. William, Jr. *Proc. Soc. exp. Biol Med.*, 1943, 52, 282–284.

A Low-Temperature Continuous Extractor[1]

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When extracting proteins and other organic materials with organic solvents it is often necessary to carry out the extractions at reduced temperatures to avoid denaturing or destroying them. This is usually done in flasks, necessitating large volumes of solvent and much handling. An extractor requiring relatively small amounts of solvent, very little handling of the material being extracted, and with safeguards protecting the solvent from absorbing water is described (Fig. 1).

The material to be extracted is placed in a thimble, H (43 x 123 mm.), which is then inserted in the vacuum-jacketed extraction chamber, F. The solvent is placed in the round-bottomed flask, I (1 l.), and some is also placed in the trap. On boiling the solvent, the vapor rises up the glass column, is condensed in the bulb condenser, passes through the cooling coil, C (8-mm. tubing), into the extraction chamber, and then siphons off and returns to the flask.

Cooling is achieved by the bulb condenser and the cooling coil. When using solvents with high boiling points, ice water can be circulated through the condenser, but with those such as acetone and ether, the temperature of the tap water suffices. A solvent such as acetone is circulated in the jacket, G (35 x 8 cm.), surrounding the cooling coil, and is cooled by passing through a copper coil, B, immersed in a Dewar flask containing a cooling medium such as CO_2-acetone. The acetone enters the

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[1] The work during which this development occurred is supported by a grant from the Rockefeller Foundation.

bottom of the jacket and leaves by way of the glass tube suspended in the center of the cooling coil. By using CO_2-acetone as a coolant, temperatures as low as −65°C. can be maintained in the extraction chamber.

The temperature can be controlled by empirically determining the temperature in the CO_2-acetone bath necessary to keep the extraction chamber at the desired level or, more easily, by a thermoregulator, D. The thermoregulator used in this laboratory is of the type commonly employed in commercial refrigeration. It controls the circulating pump, E, and with the CO_2-acetone in the Dewar kept from 20°–30°C. lower than that desired in the extraction chamber, the temperature can be maintained within ±1° C. down to −20°C. For lower temperatures the thermoregulator is shorted out, and the pump runs independently of it.

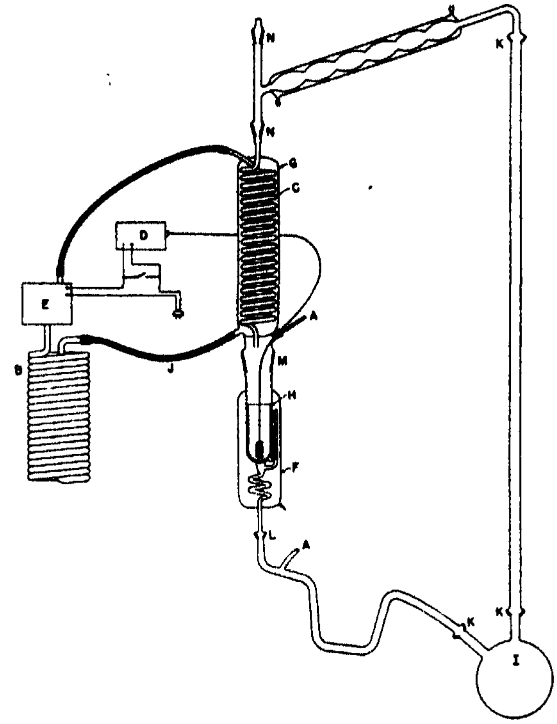

FIG. 1

The temperature in the extraction chamber is obtained by placing a thermometer outside the thimble and observing it through the walls of the chamber. A thermocouple may be inserted through the same opening at which the thermoregulator enters.

Openings to the atmosphere, provided at A, are connected to $CaCl_2$ tubes. Ball and socket joints, K (28/15) and L (18/9), permit easy handling and prevent strains in the setup; the other joints, N (19/38) and M (60/50), are standard taper. Rubber tubing, J, connects the copper coil with the cooling jacket.

The apparatus lends itself readily to successive extractions with different solvents merely by changing the solvent in the flask and trap. The residual solvent in the extraction chamber is removed by applying suction to the outlet of the extraction chamber, L.

An Alternate Method of Cleaning Mercury

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The classical operation of squeezing mercury through a chamois often leads to extensive spilling unless a mercury press is used. A simple and thoroughly satisfactory alternative method utilizes nothing more than vacuum filtration in place of squeezing through the chamois. The schematic arrangement is shown in Fig. 1.

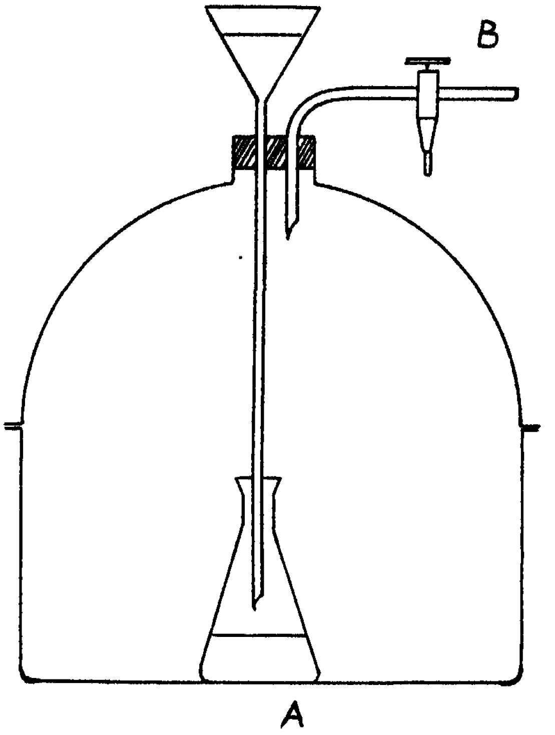

FIG. 1

The vessel, A, is a Pyrex low-vacuum distilling apparatus, and B is a three-way stopcock with an outlet through the plug. In operation, a 2-inch, long-stem funnel requiring only a 4-inch square of chamois will filter, on house vacuum (ca. 25–35 mm.), 5 pounds of mercury within a few minutes. As a receiver, a 500-ml. Erlenmeyer flask will hold splattering down to a minimum. The weight of the mercury and the effect of the suction are sufficient to hold the chamois snugly against the funnel so that air does not leak between the funnel wall and chamois.

When cleaned mercury is to be used immediately, a filter flask of the appropriate size can be substituted for the receiver and vacuum chamber. When, however, it is desired to catch the mercury directly in a cleaned container for storage, the vacuum chamber is preferred, permitting the use of almost any size and shape of container. The container may be removed, stoppered, and put away without again handling the filtered mercury.

This method has been used by the author over a period of time with excellent results in rapidity of filtering; in cleanliness of mercury, and in minimum of loss.

Book Reviews

Electrons (+ and −), protons, photons, neutrons, mesotrons, and cosmic rays. (Rev. ed.) Robert A. Millikan. Chicago: Univ. Chicago Press, 1947. Pp. x + 642. (Illustrated.) $6.00.

Robert A. Millikan's new book on the electrons and other particles of modern physics is not so much a revision of the earlier editions as a reprinting with a supplement. The first 10 chapters are almost identical with the 1924 revision of the original book, called *The electron*, which was published in 1917. The next 5 chapters were added in the 1935 edition, and the last 5 are new.

As is explained in the Introduction, the book is devoted mainly to the researches of Millikan himself and his associates. However, the background and theoretical implications of the experiments are given in such detail, and Millikan's work has involved so many fields of physics, that the book amounts to a fairly complete review of atomic physics in the 20th Century.

It begins with the history of the atomistic concept of electricity, which culminates in Millikan's famous oil-drop experiment to measure the electronic charge. Following this, the problem of the nature of radiant energy provides background for Millikan's photoelectric experiments, which verified the crucial Einstein equation. Then the experiments of Bowen and Millikan in spectroscopy shed new light on the structure of atoms and led to the discovery of the spin of the electron. Finally we come to the work of Millikan and his associates on cosmic rays and nuclear physics—work which has been responsible for much of our present-day understanding of these subjects.

The new chapters may be summarized briefly as follows: One chapter explains how nuclear energy is released and discusses the practicality of commercial use of nuclear energy as a source of power. It seems to this reviewer that the chapter is not very well written or very scientific in the manner of drawing political, economic, and social conclusions from incomplete data.

A second chapter summarizes in detail the geomagnetic studies of cosmic rays made by Millikan, Bowen, and Neher in the years 1920–36. An explanation is also given of Millikan and Cameron's failure, in 1926, in their first effort to find a geomagnetic effect.

The third of the new chapters relates the history of the discovery of the mesotron and describes the properties of this particle. It is shown how the existence of such a particle was indicated by the high-altitude surveys made by Millikan, Bowen, and Neher and conclusively proved by the cloud-chamber data of Anderson and Neddermeyer.

The last two chapters are devoted to the nature of the primary cosmic rays and particularly to Millikan's hypothesis concerning the origin of these rays through the process of annihilation of atoms in interstellar space.

Any reader of the book who is not a learned physicist should be warned of the following: (1) Although the early chapters have been touched up slightly in an effort to modernize them, the effort has not been completely successful. Thus, the picture of the atom and its nucleus presented by Millikan in Chapter IX is definitely a 1924 painting with a few daubs of 1935 and 1946 paint; a 1946 picture would be somewhat different. Similarly, the first chapters on cosmic rays constitute a 1935 picture. (2) Over the years between editions of this book, common usage has changed with regard to the meanings of a few of the words. As a result, Millikan's book is not entirely consistent in word meanings, either within itself or as compared with other modern texts. For instance, his "positive electrons" may be either protons or positrons, and his "fast electrons" may be mesotrons or high-energy protons, positrons, or electrons. (3) Not all of the declarations made by Millikan meet with agreement among other prominent and competent physicists. In particular, many physicists feel that the evidence in favor of Millikan's hypothesis regarding the origin of cosmic rays is not as strong as one would gather from the book. (4) As a survey of modern physics, the book is far from impartial. The scientific world here presented has its center obviously in the Norman Bridge Laboratory at the California Institute of Technology.

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Bioelectric fields and growth. E. J. Lund and collaborators. Austin, Texas: Univ. Texas Press, 1947. Pp. vii+391. Illustrated.) $6.00.

This important experimental contribution to the literature of biophysics supports the senior author's thesis that continuous, self-generated electrical fields operate as primary correlating mechanisms in living systems lacking nervous and circulatory devices, e.g. in the control of embryonic growth pattern.

About one-fifth of the space is devoted to the effects of externally applied electric fields upon polar growth in the onion root, *Avena* coleoptile, and reassociated cell masses of *Obelia*. The remainder is concerned with (1) measurement of the distribution of potential differences in space and time and in relation to environmental factors in *Pithophora* (a linear cell aggregate), the mantle of *Anadonta* and *Unio*, the onion root, and the coleoptile of *Avena*; (2) the counter-EMF developed in the onion root by applied currents in relation to intensity, duration and direction of current, region of the root, and effects of oxygen and cyanide; and (3) the capacity of frog's skin to perform electrical work and the efficiency of the process. The importance of these last three types of data cannot be overemphasized, for understanding of the control exerted by external electric fields rests upon knowledge of their effects upon the fundamental physiological properties of the growing systems. Extrapolation of such knowledge to the morphogenetic fields operating in normal development demands, in addition, complete information of the spatial and temporal distribution of the self-generated electrical potentials and the patterns and limits of internal electrical energy expenditure.

A valuable addition is the beautifully cross-indexed bibliography of 1406 titles on continuous bioelectric currents and bioelectric fields, by H. F. Rosene.

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The Nature and Importance of Physiologic Specialization in Phytopathogenic Fungi

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PHYSIOLOGIC SPECIALIZATION IN PLANT pathogenic fungi is an old subject that is always new. It has long been known that within species of most pathogenic fungi there are many biotypes or physiologic races that differ principally or solely in physiologic rather than morphologic characters. It also has been known for about a quarter of a century that it is necessary to know the number, geographic distribution, and pathogenic potentialities of races to understand the development of epidemics and the regional and seasonal variation in the disease resistance of many crop plants. Moreover, it has become increasingly apparent that knowledge of physiologic specialization is important in formulating plant quarantine regulations and in the breeding of disease-resistant varieties. There are indications that it may be important also in the control of diseases by the use of fungicides and soil management practices.

It is not the purpose of this paper to catalogue specific facts about physiologic specialization but rather to evaluate what we know and indicate what we need to know. As practical needs must be met by special investigations in the multitudinous special cases, it seems desirable to discuss general principles.

The term physiologic race usually is used to designate intraspecific biotypes or groups of biotypes that can be distinguished by consistent behavior in pathogenicity. It is implied that races are essentially alike morphologically; but there may be some differences in morphology also, as is certainly true of haploid races within *Ustilago zeae*, which comprises sporidial, mycelial, and many intergrading types. In general, intraspecific lines are designated as physiologic races if morphologic characters are neither sufficiently great nor consistent to justify designating the lines as varieties. It is the usual practice, then, to apply the term physiologic race to lines or collections of plant pathogenic fungi if the most conspicuous or most important differences between them are in pathogenicity, even though there may be appreciable morphologic differences also.

Physiologic races may differ in growth rate, size, color, topography, and other characters of colonies on artificial media; in sex and mutability; in nutritional and temperature requirements; in enzyme activity; in tolerance to pH concentrations, poisons, fungicides, or toxins; in ability to produce substances toxic to plants; in pathogenicity; and in many other characters. The number of races within many species, the abundant production of new ones, and the number of characters in which they may differ require many criteria for distinguishing between closely related races or sometimes even between distantly related ones.

Puccinia graminis tritici, stem rust of wheat, which is itself a variety of *P. graminis*, comprises, for example, an indefinite number of pathogenically different biotypes. Each of the 189 described races may comprise one or more of these biotypes. For practical purposes these races are identified by inoculating about 20 seedling plants of each of 12 so-called differential varieties of *Triticum* spp. These were selected as differentials a number of years ago because they seemed to be representative of several hundred varieties that had been tested for reaction to the rust races then known. But plant breeders have subsequently developed many new varieties of wheat, and consequently there are many potentially new differentials that may enable the recognition of racial differences not formerly apparent. Naturally, therefore, it is necessary to test these new varieties against available races. But not enough races are available, because the process of identification, description, and recording has been in progress for about 30 years, and some races that were common then are no longer found. Also, there can be no certainty that a rust collection that was identified as race 8 a quarter of a century ago is identical genotypically with one that is so identified today. Unless all races are maintained permanently in living condition and in pure form under standardized conditions, which is practically impossible, a collection identified as race 8 today must be compared with the record of performance of race 8 many years ago; it is a comparison with a record, not with a type specimen. Despite this difficulty, the agreement of the records often is so remarkable that doubts regarding genotypic identity seem unimportant for practical purposes.

Regardless of the inherent difficulties in identifying physiologic races of an obligate parasite like *P. graminis tritici*, relative precision can be attained. Seedlings of the 12 differential varieties are inoculated in the greenhouse with rust collections, placed in a moist chamber for 48

Vice-presidential address delivered at Boston, December 27, 1946, before Section G, AAAS.

hours, kept on a greenhouse bench; and in about two weeks, the exact time depending on light intensity and temperature, identification can be made. The degree of susceptibility of the differential varieties may range from immune to completely susceptible, corresponding with well-defined infection types ranging from 0 to 4, with a variable type X, produced by certain races on certain varieties. Infection types 0, 1, and 2 are clear-cut indications of resistance, and types 3 and 4, of susceptibility. Type X indicates a "mesothetic" or variable reaction. Races can then be identified by means of a trichotomous key based on resistance, susceptibility, or a mesothetic reaction of the differential varieties. But there are degrees of resistance and susceptibility. Thus, all of the differential varieties except Khapli emmer are susceptible to race 15, first identified more than 25 years ago. But there are degrees of susceptibility. Several years ago there was obtained from Brazil a collection to which some of the differentials were decidedly more susceptible than to one from the United States. On the other hand, several varieties were less susceptible to a collection from Japan than to that from the United States. According to the key for the determination of races, all three collections were race 15. They were, however, different, and accordingly were designated as races 15, 15A, and 15B. From a scientific standpoint it would be justifiable to designate them as distinct races; from a practical standpoint there is advantage in considering them as biotypes of the same race. Many others of the 189 numbered races are known to comprise several biotypes. In reality, then, there are many more races than the 189 that have been numbered.

It is becoming increasingly evident that *P. graminis tritici* comprises an indefinite number of biotypes that differ in pathogenicity and other physiologic characters. It is equally clear that the differences between many of them are so slight as to defy easy and certain identification by the methods that are available. Phenotypic variability sometimes may obscure genetic differences between closely related biotypes, or even between certain closely related races, in so far as genetic relationship is indicated by the reactions of the relatively few wheat varieties that can be used because of limitations of time and space. Light, temperature, varietal purity, and vegetative vigor of the inoculated wheat plants cause considerable variation in infection types. As an extreme example, certain varieties of wheat may be highly resistant to a given race at 65° F. and completely susceptible at 85°. Differences in light intensity may have almost as great an effect. Were it possible to make large numbers of precise studies at the same time, at constant temperatures and light intensities and with standardized test plants, it would be easier to recognize the multitudinous biotypes that are known to exist. But it would even be necessary to have several sets of standardized conditions, because different biotypes may behave alike under certain sets of conditions and differently under others. The best that can be done, then, is to study large numbers of biotypes crudely and smaller numbers intensively. In identifying races for practical purposes it is necessary to lump rather than split. Although this lumping does not reveal the great complexity of biotypic components of a single variety of *P. graminis*, it does satisfy certain practical requirements in understanding and combating a destructive pathogen.

The physiologic races of *P. graminis tritici*, as the expression has been defined, can be identified with reasonable facility and certainty. Although isolations can be made from different types of pustules if two or more races occur in a mixture, still greater assurance of purity can be attained by isolating single urediospores and establishing monosporous lines, which can be propagated indefinitely as dicaryotic clones. As observable mutation for pathogenicity seems to be rare in the rusts, it is not particularly difficult to maintain the essential genetic purity of lines. But this is not true of many other fungi, such as smut fungi and many of the Fungi Imperfecti.

In the smut fungi the term physiologic race is usually used to designate chlamydospore collections that are relatively consistent in pathogenicity on certain varieties of plants. The original inoculations usually are made with a considerable number of spores, and successive crops of chlamydospores are then tested to determine the consistency of their behavior. As chlamydospores are diploid, and sexual reproduction intervenes between one generation and the next, a "chlamydospore line" comprises a changing population of biotypes. The pathogenicity of lines is, however, often remarkably consistent in replicated tests in the same year and in successive years. Thus, the writer and associates several years ago inoculated several varieties of corn in the field with collections of *U. zeae* from a number of different states of this country; the degree of infection, as measured particularly by size of smut galls, ranged from light to heavy. Chlamydospores produced by each collection were then inoculated into corn the next year, with almost exactly the same results. The same procedure was followed a third year, and again the results were similar to those of the first two years. Theoretically, this would not be expected, because of the opportunity for changes in biotypes within each smut collection. In this and other cases, however, it appeared that the changes were usually not great enough, within the relatively short duration of the experiments, to become perceptible on corn plants. An industrious investigator could, however, spend a lifetime in studying biotypes within any one of these collections. There would be distinct differences between many of the biotypes within each collection, but the populations of biotypes apparently retain their distinctive characters for some time when judged by their pathogenicity on corn. Further study is being made of the geographic distribution and the stability of such "chlamydospore populations."

The corn smut fungus, then, comprises an indefinite number of haploid biotypes that may differ in so many physiologic characters that they could be considered as physiologic races. Since haploid lines cannot cause infection singly, however, they are usually not so designated. But monosporidial diploid lines also can be isolated. These can propagate asexually by budding and thus maintain themselves indefinitely as saprophytes; they can also cause infection in corn, where they produce normal smut galls and chlamydospores. Diploid lines may differ decidedly in pathogenicity, and yet they are not called physiologic races. This term is usually reserved for the "chlamydospore lines."

Clearly, then, physiologic races are different in the Uredinales and Ustilaginales. In most of the rusts they are determined by the behavior of dicaryotic clones. A culture of a given race may be maintained indefinitely in the asexual uredial stage, and some homozygous ones maintain their identity through the sexual stage also. Others, however, are so heterozygous that many segregates appear even after "selfing." In the smuts, on the other hand, it is the chlamydospores, the counterpart of rust teliospores, that are used in determining races. As the dicaryophase does not produce spores, except perhaps in a few cases, it cannot be propagated in successive generations. Moreover. as this phase appears not to thrive on artificial media, there are difficulties in studying physiological characters other than pathogenicity. But the saprophytic haplophase of many smuts can be propagated on artificial media, and the physiologic characters can be studied as in bacteria or yeasts. The pathogenicity of haploid lines, however, must be studied in paired combinations. From certain crosses between monosporidial haploid lines of *U. zeae* monosporidial diploid lines can be obtained, thus making it possible to study on artificial media the haploid parental lines singly and the diploid lines derived from them; and the pathogenicity of the dicaryophase can be studied in the host plant. Thus, studies of rusts and smuts supplement each other and furnish a rather clear picture of the continually changing diversity and complexity that may exist within species.

Physiologic specialization has been studied extensively also in such taxonomically distinct plant pathogens as *Actinomyces scabies*, *Phytophthora infestans*, *P. faberi*, *Sclerotinia fructicola*, *Venturia inequalis*, *Fomes lignosus*, *F. igniarius*, *Alternaria* spp. *Colletotrichum lindemuthianum*, *Fusarium* spp., *Helminthosporium* spp., *Rhizoctonia solani*, and many others. Since all of these can be grown readily on artificial media, certain characters can be studied that cannot be studied in obligate parasites. In many of these species a wide variety of monosporous cultural races can be isolated. Some look alike but differ in pathogenicity, and others differ in appearance but are essentially the same in pathogenicity.

Helminthosporium sativum, *H. gramineum*, and *Fusarium lini* illustrate especially well the fact that there may be an indefinite number of races, ranging from 0 to 100 per cent in pathogenicity for a single variety of wheat, barley, or flax, respectively. The order of pathogenicity may differ on other varieties, however, thus illustrating again the high degree of specificity between races and varieties of crop plants.

A. scabies, the organism that causes common scab of potatoes, is made up of a motley array of cultural races that may differ almost spectacularly in cultural characters. There are the usual differences in pathogenicity, with considerable specificity between races and potato varieties; but the scab organism is especially interesting because of the ability of different races to grow at different pH concentrations, as shown by Schaal. Potato scab usually is most abundant in alkaline soils, but the fact that some races of *A. scabies* can grow at a pH as low as 5.4 suggests that the situation might be reversed where such races predominate.

R. solani has a wide host range, including such important crop plants as potatoes, sugar beets, soybeans, beans, tomatoes, peas, alfalfa, clovers, cereal grains, and flax. There are numerous physiologic races, some of which seem to be generalized in pathogenicity, but apparently some of them are specific, attacking some plants heavily and others weakly. Some also produce diffusible substances that cause stunting or wilting of noninfected tomato and certain other plants, while others do not. This suggests that certain physiologic races of this and other soil fungi may differ in injurious effects on crop plants because of differences in ability to produce toxic substances that can act at a distance.

There is evidence also that races of some plant pathogens, such as *A. scabies*, may differ in their susceptibility to antibiotic organisms that are common in the soil. Extensive investigations are needed to determine whether the differential ability of different races of various pathogenic fungi to survive in the soil may be due partly to their ability or inability to compete with other soil organisms. The ability to produce substances antibiotic to other organisms and to withstand those produced by competing organisms may be important in survival and success as pathogens. The complex series of interactions between the large numbers of physiologic races of plant pathogens and nonpathogens in the soil may partly explain the variable results often obtained in pathogenicity tests in nondisinfected soils.

Physiologic races, as would be expected, differ in temperature relations. As an example, race 56 of *P. graminis tritici* is most pathogenic at fairly high temperatures, while races 34 and 36 are most pathogenic to certain varieties at lower temperatures. The effect of temperature varies with the rust race and the variety of wheat on which it is growing; hence, there may be a complex series of interrelationships.

From the foregoing it is evident that there may be a wide range of variation in the behavior of physiologic races, especially in their pathogenicity. Environmental conditions affect the vigor of the pathogen, the resistance of the host, and the interaction between the two. Laboratory materials and procedures can be standardized; light, temperature, and humidity can be controlled only to a limited extent in the ordinary greenhouse; conditions in the field can be controlled still less; and the microflora of the soil defies standardization unless experiments are made in disinfected soil, and then the results have only limited application. But one of the most important reasons for variability is variation in the pathogen itself.

Mutation is extremely common in many fungi—probably even more common that it seems to be. Many mutants differ so slightly from their parents and other biotypes in morphologic or physiologic characters that there are difficulties of identification similar to those already discussed in connection with physiologic races. In fact, mutants often are new physiologic races, and, unless extensive comparative tests are made between closely related ones, differences do not become apparent. When effort is concentrated on the detection of certain important character differences only, others easily can be overlooked.

From long-time studies of mutation in *U. zeae* it is evident that a single biotype may produce hundreds of mutants in a short time. Single, haploid sporidia can be isolated, and since they multiply rapidly by asexual budding on artificial media, many different characters can easily be studied. Some haploid lines are extremely mutable and others are very stable, with many intervening degrees of mutability. There is a wide range in the magnitude of differences between parents and mutants, involving one or more characters. Mutation in color illustrates the point. From a line whose colonies produce a deep tan color mutants can be obtained that differ only in almost imperceptible tints. Similarly, a series differing only in faint vinaceous shades and tints can be obtained. There are similar differences in sex, enzyme activity, pathogenicity, and even mutability. So, unless it is known where and how to look for differences, many will never be observed. Without taking extraordinary precautions to maintain the purity of certain monosporidial lines of *U. zeae*, they may soon comprise many biotypes, some of which differ in appearance and some of which are alike in appearance but different in certain important physiologic characters that are not apparent in the mixed population of biotypes. If this is true of the haplophase of *U. zeae* and other smut fungi—and it is—what is the composition of monosporous lines of *Fusarium*, *Helminthosporium*, or *Alternaria*, all of which produce multicellular spores, in some of which the individual cells are multinucleate and possibly heterocaryotic? It may be considered surprising that isolates behave as consistently as they sometimes do.

Questions regarding the importance of heterocaryosis in the production of new biotypes and the degree of their stability cannot be answered categorically—at least not by the writer. The dicaryophase of smuts and rusts is, of course, heterocaryotic. It has been shown repeatedly that degree of pathogenicity depends on the haploid lines that were combined, just as the characters of hybrid lines of higher plants depend on the genes contributed by the parents. In the smuts and rusts this is equally true of dicaryotic hybrids, in which the two haploid nuclei of each dicaryon have different genes that are not recombined until after the termination of the dicaryophase. Such special cases of heterocaryosis furnish at least a basis for the assumption that hyphal anastomoses in some fungi may result in association of nuclei with different genes. Dickinson showed that some excised hyphal tips resulting from hyphal fusions between a red and white *Fusarium* produced pink colonies, which, however, soon dissociated into the original red and white types. Possibly the association is more permanent in some fungi. From the results of Hanson and others this seems to be true; consequently, additional doubts are created regarding the degree of genetic purity of monosporous lines of some fungi.

Physiologic races may be variable also because of semipermanent modifications induced by certain environmental factors. It has long been the practice of the writer and his associates to grow smut lines on the same medium and under the same conditions of light and temperature before comparing them, because of an observed "hangover" effect. Various attempts were made to find out whether monosporidial haploid lines of *U. zeae* could adapt themselves to arsenic and other poisons other than by mutation. It is now certain that the tolerance to arsenic and malachite green can be increased by successive transfers, as Jollos showed for *Paramecium*. Monosporidial lines, both haploid and diploid, differ in their ability to develop tolerance; and there appears to be no correlation between the mutability of lines and their ability to develop it. Miss Hirschhorn made an intensive study of mutation in relation to this adaptation but found no evidence that mutation accounted for the results. Moreover, the "adapted" lines reverted to normal in appearance and lost their acquired ability after several transfer generations on arsenic-free media. The ability was acquired gradually and lost gradually just as Jollos showed for *Paramecium*. On the other hand, J. J. Christensen and associates could find no evidence that *F. graminearum* adapted itself to malachite green, ethyl mercury phosphate, and certain other substances, except as a result of mutation. In his experiments the parental line did not change, but many mutants—physiologic races—appeared in the cultures. Some grew about equally well as the parents on the poisons, some very much more poorly, and some very much better. The methods and objectives in the experiments with *U. zeae* and *Fusarium* were essentially the same, but the phenomena encountered appeared to be quite different. Easy generalization is about as dangerous here as in many of the other phases of physiologic specialization.

How important are mutation and hybridization in plant pathology? No categorical answer can be given. It is known that new races may appear—unless the supposedly new races are in reality old ones that are reappearing—and that some become established locally or regionally and attack hitherto resistant varieties of crop plants. How many of these new races were introduced from other regions and how many resulted from mutation or hybridization is not known. It is known, however, that occasional mutants—those of *U. zeae* and *H. sativum*, for example—may be more virulent than their parents. It is also known that new races, some of which are very virulent on certain varieties of crop plants, can result from hybridization, as is clearly true of certain rusts and smuts. The investigations of Keitt and his associates indicate that this is also true of the apple scab fungus.

In the smut fungi it has been shown at Minnesota and elsewhere that there may be extensive hybridization between biotypes within species, between different species, and between different genera. There is a wide range in virulence in the races resulting from recombinations. Some appear to have only slight survival ability; others are potentially dangerous. There is no information, however, regarding the origin of the new races that have appeared to attack previously resistant varieties. Investigations of the genetics of smut fungi have shown how new races can arise but not how they have arisen. The evidence is clearer with *P. graminis*.

It is known from the results of investigations in Australia, Canada, and the United States that hybridization between varieties or races of *P. graminis* on *Berberis* spp. can result in the production of many physiologic races, old and new—at least new to science. Of course, this is to be expected, as there are more than 200 known races of the tritici variety alone. A dozen or more races can even be isolated from aecia resulting from selfing certain races. Here it is possible to find out not only what can happen but also what actually does happen in nature, principally because the sexual process is localized on barberries and there are relatively quick and easy methods of identifying the resulting races.

The fact that new or unusual races of *P. graminis tritici* are produced abundantly on barberries in nature is evident from the fact that in large numbers of identifications of rusted material collected near barberries, a different race is found in about every four or fewer collections. When collections are made at random away from barberries, however, a different race is found in about every 60 collections, the exact ratio in each case depending on the year and locality or region from which the collections are obtained. As an example, in a small barberry-infested area in the eastern part of the state of Washington 32 races or biotypes were found near barberries from 1943 to 1946, and only 5 of these races were found in the entire United States away from barberries. Several of these isolates proved to be new races. In 1946, from 47 collections of rusted wheat in the same local area in Washington, 16 races were identified; in Virginia, 12 races were isolated from 51 similar collections. In the United States as a whole, on the other hand, 5 races made up 95 per cent of all isolates, and 4 made up 93 per cent. Many factors determine whether these new or rare races produced on barberries will become widely established. Many of them have not and may never become established; but, based on past experience, some of them may become prevalent and widespread.

Two outstanding examples of the establishment of new races of *P. graminis* illustrate what may happen. Ceres wheat, first distributed in 1926, was so resistant to stem rust that it soon became the most popular variety of spring wheat and occupied most of the acreage in the Dakotas and Minnesota and considerable acreage in Canada. In 1928 a new race of stem rust (race 56) was found in barberry areas in Iowa and Nebraska. This increased slowly in prevalence for several years. By 1934 it had become the most prevalent race, and it continued to increase in prevalence until 1938, when it comprised 66 per cent of all uredial isolates obtained from wheat. Ceres wheat was very susceptible to this race and was so severely injured in the epidemics of 1935 and 1937 that it was soon supplanted by other varieties. From 1934 to 1946, inclusive, race 56 has ranked first in prevalence in the United States every year except 1941, when it ranked second. Within 10 years this race spread over almost all of North America. The history of race 56 has been recited many times. It is, however, the outstanding example of the way in which a new race can appear and become widely destructive in a short time.

In the United States, race 8 of *P. graminis avenae*, the oat stem rust, has had a career similar to that of race 56. In 1937 it was found in barberry-infested areas of Iowa, Wisconsin, and Pennsylvania, and comprised only a very small percentage of the total number of isolates of oat stem rust in the United States. In 1938 it was found only near infected barberries in southwestern Virginia, but since that time it has extended its geographic range and increased in prevalence. In 1945 it comprised almost 50 per cent of all the isolates of oat stem rust in the United States, and in 1946 more than 50 per cent. It now is known to extend from Canada to south-central Mexico and at least from the Rocky Mountains to the Atlantic Seaboard. This race attacks heavily certain recently produced varieties of oats that were well on their way to monopolizing the oat acreage in many of the heaviest oat-producing areas of northern United States because of their resistance to stem rust and other diseases. These varieties were resistant to the races of stem rust that predominated while they were in the making, but the increase in race 8 has exposed them to a new and dangerous biotic environment. Fortunately, still other varieties have been produced that are resistant to race 8. But race 7, which can attack some of these varieties, has been appearing in barberry areas. Whether it will ever become prevalent, as race 8 has, cannot be predicted. In the meantime, varieties are being produced which seem to be resistant to all known races, although there is some evidence that they are susceptible to certain of them at high temperatures.

Some of the best stem rust-resistant commercial varieties of spring wheats now grown in the United States are resistant to race 56 and the other races now prevalent but are susceptible to certain as yet unprevalent races that are found only near barberries. Crosses now are being made in the attempt to produce varieties resistant to these races, should they duplicate the history of race 56. Moreover, it is known that there are rust races in certain other countries that are far more virulent than anything yet found in North America. Whether these will ever be produced naturally in North America, whether they will be introduced, or whether they will be carried into North America by the wind are questions that only the future can answer. Plant breeders and plant pathologists proceed on the assumption that the sort of thing that has happened in the past may happen in the future. But to prepare for the future it is necessary not only to know the physiologic races of the present but also to learn the principles basic to predictions regarding those which are potential.

The National Academy of Sciences:

Abstracts of Papers Presented at 1947 Meeting

The Sun a Regular Variable Star

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The variation of values of the solar constant of radiation for the years 1924–44 reveals a regular periodicity of 6.6456 days. Statistical studies of temperature departures at Washington, D. C., St. Louis, Missouri, and Helena, Montana, show that this solar periodicity is attended by fluctuations of temperature of identical average period and an average range of 5°F. Apparently these temperature fluctuations have not hitherto been recognized as periodic because, while the solar period is invariable, its terrestrial effects are subject to phase displacements of ± 1, 2, and occasionally 3 days, and the amplitudes of the temperature effects range from 2° to 20°F.

Blood Protein Studies With Labeled Elements

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In mammals, absorption of the most essential foodstuffs from the gastrointestinal tract is indiscriminate; it does not depend on whether or not the body is already liberally supplied with this substance. The disposal of surplus amounts is through degradation and excretion.

The metabolism of iron has been found not to follow this general rule. Hemoglobin, the iron-containing red protein of the blood erythrocyte, is the primary means of oxygen transport in mammals. Iron is thus essential to mammalian life. Early studies with radioactive iron show that in this case the body excretes surplus iron only in negligible amounts. Instead, normal dogs and humans absorb iron from the gastrointestinal tract when needed and, when the need is satisfied, allow the iron to pass unabsorbed into the feces. Further experiment with radioactive iron, carried out by research groups a Rochester and at Berkeley, indicate that even sterile infections, such as abscesses induced by turpentine injections, prevent iron absorption in animals anemic through blood loss and needing iron. Also, such infections prevent hemoglobin formation even from injected iron.

An average life span of 120 days for the dog erythrocyte is indicated from studies on excretion of porphyrin breakdown products by Hawkins and Whipple. Studies with radioactive iron aimed at confirming this life-span figure failed to give adequate data for this purpose for an unexpected reason: it was found that the dog utilizes almost exclusively the iron liberated from his own worn-out red cells for building new ones, even with very large stores of other reserve iron in his body.

Later, Shemin and Rittenberg showed, by the use of the distinctive heavy isotope of nitrogen, that glycine nitrogen is the source of the porphyrin nitrogen of the hemoglobin. In subsequent experiments, in which such a labeled glycine was fed to a human subject and then the rate of disappearance of the resulting labeled hemoglobin followed, they have shown that the average life span of the human red cell is also about 120 days.

Distinctive isotopes, radioactive and stable, are also of proven value in investigations of blood-plasma proteins. Originally, it was supposed that in addition to forming a blood clot following injury, their function was principally that of maintaining the osmotic pressure of the blood and thus preventing plasma loss into the intercellular tissue spaces. Later, vital immunological functions were definitely attributed to certain of these proteins.

In 1938, Howland and Hawkins showed that injected plasma protein can be used by dogs for other nutritional purposes, apparently without ever passing through an amino acid stage in the plasma. This indication that the plasma proteins may be important intermediaries in protein metabolism receives added support from work by Schoenheimer and his associates at Columbia University. From their data they suggest an average half-life of about two weeks for plasma protein molecules. Work carried out at Rochester in which tagged plasma proteins synthesized in one dog were reinjected into a second animal suggests an even shorter lifetime in the blood stream for the average plasma protein molecule. They find 50 per cent of the labeled material gone from the plasma in 30 hours and 75 per cent gone in 6 days.

Tarver and Reinhardt have recently carried out plasma protein studies which strikingly indicate the importance of the liver as a site of plasma protein production. When methionine, labeled with radioactive sulfur, is administered to completely hepatectomized dogs, they find that plasma globulin synthesis is depressed to $\frac{1}{3}$ of normal and albumin synthesis to below $\frac{1}{10}$ of the normal value.

Such results point out that one of the particularly valuable uses of labeled isotopes depends upon their ability in many short-term, acute studies to give valid data concerning the quantitative aspects of physiological functions. Such results also suggest that, through the use of suitable labeled amino acids, it will be possible to measure the efficiency of the human liver in synthesizing plasma proteins in health and disease.

Ovular Tumors Associated With Hybrid Embryos in *Datura*

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It has been shown by one of us (S.) that, following pollination of *D. stramonium* by a distinctly related species, *D. Metel*, hybridization takes place freely, but the hybrid proembryos abort usually at or before the 8-cell stage, accompanied by an enlargement and proliferation of the cells (endothelium) immediately surrounding the embryo sac. Such proliferating cells may invade the embryo sac and form ovular tumors or "pseudo-embryos." Similar abnormal growth has been found in other wide crosses. Ovular tumors are also the rule from the cross 4n x 2n as well as from the reciprocal cross 2n x 4n when both parents belong to the same inbred line of *D. stramonium*. The fact that van Overbeek and Conklin have induced such ovular tumors in *Datura* by injection of auxins indicates connection with chemical changes in their microenvironment and suggests the possibility of a further analysis of the factors in microenvironment responsible for differentiation in normal development as well as for abnormal growth with hope of their ultimate control.

The Surgical Treatment of Congenital Pulmonic Stenosis

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Congenital defects of the heart and the great arteries arising from the heart are not uncommon. There was no satisfactory surgical treatment for any of these prior to 1938. Since that time, advances have been made in the surgical therapy of three of the most common types, namely, patent ductus arteriosus, coarctation of the aorta, and pulmonic stenosis. Methods for treating some of the other deformities will probably be developed.

This presentation will be limited to a consideration of the treatment of pulmonic stenosis, which is a constricting deformity of the main artery to the lungs at the point where it arises from the heart. This deformity is usually associated with additional defects in the heart, but the major disturbances are caused by the pulmonic stenosis. Patients with this deformity are cyanotic and are commonly called "blue babies." More important than the color change is the fact that the patients have definite restriction in their physical activities. The red blood cell count is greatly increased, and the oxygen saturation of the arterial blood is greatly decreased. As stated previously, the major factor responsible for these findings is an inadequate flow of blood through the lungs as a result of the pulmonic stenosis. Oxygen is available in the lungs, but the flow of blood to the lungs is so reduced that an adequate quantity of oxygen is not delivered to the body.

The operation which has been developed for the treatment of these cyanotic patients is a shunt or by-pass procedure and consists in the making of an anastomosis between a large branch of the aorta and the pulmonary artery distal to the point of stenosis. Fortunately, the pulmonary artery is usually essentially normal except for the stenotic area. Following the establishment of this artificial communication, the high pressure in the aorta causes a large quantity of inadequately oxygenated blood to flow through the pulmonary artery and the lungs, and this blood returns to the heart with a high degree of oxygen saturation.

During the past 30 months 375 cyanotic patients who were diagnosed as having pulmonic stenosis (the tetralogy of Fallot) by Dr. Taussig and her associates have been operated upon in the Johns Hopkins Hospital. The ages have ranged from 4 months to 26 years. The over-all mortality rate has been approximately 17 per cent. Most of the patients who have survived the operation are strikingly improved. In many of these the cyanosis and the clubbing of the fingers and toes have disappeared, the red blood cell count has declined to normal, and the oxygen saturation of arterial blood has increased greatly. Some of the patients who could walk only a few feet before operation can now walk miles.

Relativistic Correction to the Magnetic Moment of the Deuteron

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The corrections referred to are considered for a proton and neutron moving in each other's field. Two alternative equations are used as starting points for the calculations. One of these is an extension of the electrodynamic laws of interaction between charged particles; the other is typical of Hamiltonians giving rise to inverted (Thomas term-like) vector spin orbit doublets and is an extension of the scalar field one-body equation. The calculations reported on here show about the same degree of sensitivity of the relativistic correction of the deuteron's moment to the type of interaction assumed between particles as has been obtained previously

(G. Breit. *Phys. Rev.*, 1947, 71, April 15) in simplified considerations with a single particle model. It is concluded, therefore, that one cannot be sure of estimates of relativistic corrections to approximately their whole magnitude and that even the sign of the correction cannot be considered as certain. Considerations regarding additivity of nuclear moments involving an accuracy of much better than .01 nuclear Bohr magneton appear to be obscured not only by the presence of relativistic corrections but also by the remoteness of sufficient knowledge concerning the interactions between particles which is essential for the determination of the effects of relativity.

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The Physical Basis for the Use of Isotope Tracers in Biology and Medicine

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Some of the characteristics of radioactive isotopes which make their use so valuable in biological research are discussed. These include the ease of detection of extremely small quantities of certain of the isotopes, the rapidity of scanning a large number of samples for qualitative measurements, and the ability to trace a particular element (once tagged by being made radioactive) in the presence of large amounts of that same element. Certain limiting characteristics such as half-life, energy of the emitted particles, low specific activity, and physiological changes produced by the radiation of the labeled substances are presented. The stable isotopes are also considered in a similar manner, the extremely valuable characteristics as well as the limitations being given.

Production of Mutations in *Drosophila* by Treatment With Some Carcinogens

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Males of *Drosophila melanogaster* have a large supply of mature sperm in their testes. A method has been developed for treating these males with various chemicals by keeping them in an atmosphere containing an aerosol of a solution of the desired chemical. It has been found that by means of such treatment the sperm in the testes of exposed males may be reached and genetic changes in the sperm produced.

After the effect of aerosols of 19 chemicals had been tested without any detectable genetic change in the sperm, an aqueous aerosol of a nitrogen mustard—methyl-*bis*(β-chloroethyl)amine—was tried, because Auerbach and Robson had induced mutations by exposing *Drosophila* males to a vapor of that mustard. Results of the treatment with mustard aerosol were positive. Both mutations and chromosomal rearrangements were obtained. These results proved the effectiveness of the aerosol method.

Subsequent experiments with aerosols of four carcinogens (1,2,5,6-dibenzanthracene, methyl cholanthrene, benzpyrene, and β-naphthylamine) gave positive results. Experiments with dibenzanthracene have progressed far enough to show that this chemical induces both gene changes and breaks in chromosomes. The gene mutations are not specific. Analysis indicates that the affected genes are distributed at random along the X chromosome. The genetic effect of dibenzanthracene is very similar to the genetic effects induced by radiations (X-rays, ultraviolet, neutrons).

Up to the present time, mutations have been induced experimentally by radiations, mustards, and the four chemicals mentioned here. All known mutagenic agents that have been adequately tested are also carcinogenic. This close correlation between carcinogenicity and mutagenicity gives experimental support to the hypothesis that cancer may originate as a result of a mutation occurring in a somatic cell.

Solar Effects in Cosmic Rays

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(Introduced by M. A. Tuve)
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During the past 10 years three unusual and sudden increases in cosmic ray intensity, lasting several hours, have been observed simultaneously in different parts of the world, except at the equator, where no increase was observed. All three increases began nearly simultaneously with unusually long and intense radio fadeouts and solar flares and were similar and simultaneous on the day and night sides of the earth. Magnetograms from several magnetic observatories indicate that the increase in cosmic ray intensity cannot be ascribed to changes in the earth's magnetic field. While such increases might be ascribed to changes in the sun's general magnetic field, which would permit more cosmic rays from outer space to reach the earth, such a mechanism should be equally effective whether the solar flare occurred on the front or back side of the sun. This, with other arguments, indicates that changing magnetic fields associated with a sunspot or flare may act as a magnetic accelerator for charged particles. Similar processes on stars might account for all cosmic rays.

Beneficial Mutations in Laboratary Strains of *Drosophila*

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Experimentally observed mutations are deleterious or, at best, neutral to their carriers. This seems to contradict the view that the process of mutation supplies the raw materials from which evolutionary changes are compounded. The contradiction is, however, spurious. Any mutation found in experiments has, presumably, arisen many times in the history of the species. A mutation that furthered the adaptation of a species to its normal habitat would have been selected and established as the "normal" or wild-type condition. To detect beneficial mutations, strains that carry deleterious genetic variants, which reduce the viability below normal, must be chosen as initial materials; in such strains, mutations that cancel the deleterious effects and bring the vigor and vitality back to normal may be expected to occur. This expectation has been tested by observing the behavior of 7 strains of *Drosophila pseudoobscura* for 50 generations. The initial 7 strains were known to be homozygous for certain second or fourth chromosomes that reduced either the viability of the flies or their development rate, or both. The strains were kept in overpopulated cultures at 21°C. for 25 generations, and at 25½°C. for the following 25 generations. In one subline of each strain the male parents were given a treatment of 1,000 r-units of X-ray in each generation; the second subline was untreated. To test the changes in the viability and development rates, 410,784 flies were classified and counted. Improvements of the viability were observed in 5 of the untreated and in 6 of the X-ray-treated lines; in some of these lines, the improvements were quite striking. Speeding up of development rates was also observed in several strains. The behavior of the X-rayed and the untreated lines was, on the whole, similar, although irradiation is known to have induced many deleterious changes; such changes were eliminated by natural selection.

Studies on the Permeability of Mammalian Membranes

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The vascular system and placenta are discussed as examples of those membranes of mammals which have been studied in this laboratory by means of radioactive and stable isotopes.

When water tagged with heavy water, sodium, or chloride, each labeled with one of its radioactive isotopes, is injected intravenously into the guinea pig, the concentration of the labeled substance rapidly decreases in the blood plasma and is at equilibrium in less than 10 minutes. The loss of labeled substance with time follows a rather regular curve from animal to animal. This curve is fitted by a single exponential from which the normally occurring rate of loss of the water, sodium, and chloride of the plasma can readily be determined. We have been surprised by the extraordinarily rapid rate at which the water, chloride, and sodium of the plasma are exchanged through the walls of the blood vessels with water, chloride, and sodium of extravascular fluids. Water of plasma is exchanged at the rate of 140 per cent/minute; chloride, at the rate of 128 per cent/minute; and sodium, at the rate of 60 per cent/minute. From these values it is evident that the walls of the blood vessels are 2.3 times as permeable to water as to sodium and 2.1 times as permeable to chloride as to sodium.

The permeability of the placenta, *i.e.* the rate at which a substance reaches the embryo from the maternal blood stream across a unit weight of placenta, has been studied with heavy water and radioactive isotopes of sodium and phosphorus. The permeability increases markedly as pregnancy proceeds. In man, for example, the permeability to sodium increases about 70 times from the 9th to the 36th week of gestation. A reasonable explanation of this increase is to be found in changes in the microscopic anatomy of the placenta. The placenta of the guinea pig is about 10 times as permeable to water as to sodium and about twice as permeable to inorganic phosphate as to sodium. The embryo receives, on the average, about 300 times as much water across the placenta from the mother as is retained in its growth and about 50 times as much sodium, whereas the inorganic phosphate supplies little more than meets its needs.

It is to be remarked that observations of this kind could hardly have been made in any other way than by the use of the isotope technique.

A New Structure for Soap Micelles and the Polymerization of Rubber

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Solutions of soaps and other detergents have many remarkable properties which have been utilized in manifold ways, from the killing of bacteria to the preparation of fabrics and to cleansing. Several of these properties are of fundamental importance in the emulsion polymerization of rubber and other polymers in which aggregates of soap molecules known as micelles play a most important role. The size of these aggregates is not definitely known and has been the subject of much discussion for many years. For example, McBain considers that there are two types of micelles in aqueous solutions: (1) a small, spherical aggregate which is highly ionized, and (2) a "great," or lamellar, micelle which consists of a pile of double layers of soap. Recently, in the laboratory, R. W. Mattoon and R. S. Stearns have measured the thickness of soap micelles by a newly discovered X-ray band, and this, together with certain theoretical considerations, leads to the following picture:

A moderate number of soap molecules, possibly 100-200, at a certain definite, or critical, soap concentration, collect together in order to escape as much as possible from the water and yet remain inside it. In the case of an ordinary soap, the negative ions—for example, $C_{13}H_{27}COO^-$, if it is a myristate, consisting of the long paraffin chain $C_{12}H_{27}^-$ and the polar group COO^-—aggregate with the hydrocarbon chains lined up against each other in a double ionic layer. The polar COO^- groups turn toward the water and the hydrocarbon chains toward each other to make a double layer of soap molecules, which, with this particular soap, has a thickness, as determined by X-rays, of about 45 A.—twice the length of a molecule of potassium myristate. These micelles, or double layers of soap, possess the remarkable property that they dissolve excessively thin layers of oil from 6 to 15 A. thick between the ends of their hydrocarbon chains. In the synthesis of rubber this layer of oil consists of 25 per cent of styrene and 75 per cent of butadiene.

Thus, there is formed a two-dimensional solution which, for its third dimension, gives a thickness of only 15 A. This, under the action of a catalyst, polymerizes and gives rise to molecules of rubber. In cleansing the skin, a similar two-dimensional solution is formed from the oils of the skin. Part of the cleansing action of a soap is due to this property, known as solubilization, although much of it is due to the emulsifying action of the soap.

Recently, in work by M. L. Corrin, a new rapid and powerful method has been discovered for the emulsion of the critical concentration at which soap micelles aggregate. By the use of this method it has been found that in their formation the general principles involved in the behavior of aqueous solutions of ordinary electrolytes, such as the principle of ionic strength and the Debye-Hückel relations, are entirely invalid. By the uses of changes in fluorescence of certain dyes it is found possible to determine the concentration of free soap in rubber latex, a quantity which is intimately related to the rate at which the polymerization of rubber and other polymers occurs.

Other interesting relations are involved.

The Use of Isotopic Carbon in Metabolism Studies

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A brief résumé on the use of isotopic carbon in the study of reactions involved in the conversion of lactic acid to glycogen is given and the role played by CO_2 in the reactions discussed. A method for producing glycogen *in vitro* and the preliminary results obtained from the use of the long-life carbon isotope, C^{14}, are presented.

Forces Between Polyatomic Molecules

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A number of the properties of liquids and solutions composed of nonpolar, polyatomic molecules obey rather well certain equations derived by the aid of models with spherical molecules and radical force fields; nevertheless, the volatility of species such as OsO_4, UF_6, and Ni $(CO)_4$ indicates that the buried atoms contribute but little to the molecular field and suggests that the peripheral atoms might well be considered as the main centers of attraction. This is tested by comparing the entropies of vaporization of liquids whose molecules differ considerably in size but whose peripheral atoms are identical. Pitzer has shown that two liquids should have the same entropy of vaporization when compared at temperatures where they have the same ratio of vapor to liquid volume, provided, among other things, that they have the same type of radial force field, as is the case with the rare gases. An approach free from this restriction leads to equality when the free volume in the liquid is substituted for the total liquid volume. Comparing in both ways chlorine with carbon tetrachloride and ethane with diisopropyl, the results are in favor of the nonradial field.

Modern Processes of Color Photography

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Photography in natural colors is not new, but until recently the processes by which color photographs could be made were difficult to practice, and their use was restricted, therefore, to a small number of experts. In all processes of color photography, three separate photographic images are recorded, each being formed by the light of approximately one-third of the visible spectrum, *i.e.* by red light, green light, and blue-violet light. These three recorded images are then reproduced as colored images formed in dyes, the image recorded by red light being printed in blue-green, that recorded by green light in magenta, and that recorded by blue-violet light in yellow dye.

Modern processes of color photography depend upon the use of films coated with three superposed photographic emulsions sensitive to the three colors by which the images are recorded. In processing, the three images are transformed into the three required dye images, and a direct color photograph results. This method of color photography was suggested about 40 years ago, but it was not until 1935 that it could be realized in practice, the first color film of this type being a 16-mm. motion-picture film for use by amateurs. This first film was soon followed by others suitable for use in amateur photography and for commercial photographs from which color pictures could be printed. Today almost all fields of photography employ the multilayer films.

The dyes that produce the color images either may be supplied from the processing solutions, in which case the processing must be done under rigid laboratory control, or couplers to form the dyes may be incorporated in the coated layers of the film, which can then be processed by a much simpler method. The films may be developed by reversal to give positive transparencies in color, or they may be developed to negatives from which color prints on paper may be made.

Algebraic Orthogonal Curves

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Three kinds of orthogonality for two algebraic curves in the plane are studied: (1) simple or *weak orthogonality*, where the curves are orthogonal at one point; (2) complete or *strong orthogonality*, where they are orthogonal at all points of intersection; and (3) *total orthogonality*, where the related families $\phi = a$, $\psi = b$ form an orthogonal network. Relation to hydrodynamics and function theory is discussed.

The Effect of Centrifugal Force on the EMF of Galvanic Cells

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When a simple galvanic cell of the type

$$\underset{r_1}{\mathrm{Pt}\ ;\ I_2}, \mathrm{KI}, \underset{r_2}{I_2\ ;\ \mathrm{Pt}}$$

is placed in a centrifugal field, with the electrodes at radii, r_1 and r_2, the resulting potentials, E, are given by the thermodynamic equation

$$EF = 2\pi^2 n^2 (r_1^2 - r_2^2)\,[t_K(M_{KI} - \bar{V}_{KI}\rho) - (M_I - \bar{V}_I\rho)]$$

in which F is the faraday; n^2, the rotational speed; t_K, the transference number of the positive ion constituent; M_{KI} and M_I, molecular weights; $\bar{V}_{KI}$ and $\bar{V}_I$, partial molal volumes; and ρ, the density of the solution. The measurements may be used to determine transference numbers and, it is expected, be useful for determinations in which other methods have failed, since the electrodes do not have to carry appreciable current. Early work on the method was carried out by T. des

Coudres (*Ann. Phys. Chem.*, 1893, 49, 284) and R. C. Tolman (*Proc. Amer. Acad.*, 1910, 46, 109).

To develop the method to yield accurate results it has been necessary to recognize and eliminate sources of error. The chief of these were found to be (a) oxygen in the solution and surroundings of the cell; (b) the colloidal particles in the solution which are thrown to one or both of the electrodes; and (c) temperature gradients in the cell.

The first of these errors has been eliminated by replacing the oxygen with nitrogen; the second, by ultrafiltration; and the third, mainly by causing the rotor to operate in a vacuum. High precision in the measurement and control of the speed has been attained.

Topological Methods in the Theory of Functions of a Complex Variable

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The study of harmonic functions u(x,y) by the method of investigation of the singularities of the level lines of u(x,y) can be extended to that class of functions which are termed pseudo harmonic and which are obtained from harmonic functions by a local 1-1 deformation of the (x,y) plane near any given point. This theory, carried over to the theory of functions f(z) of a single complex variable, permits the discovery of new theorems connecting the count of zeros, poles, and branch point antecedents of f in terms of topological characteristics of the boundary values of f.

Geographical Aspects of the Epidemiology of Poliomyelitis

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During the recent war years there have been opportunities for the epidemiological study of poliomyelitis as it has affected American soldiers and native populations in various parts of the world, such as North Africa, the Middle East, and the Far East. From this experience it appears that in certain countries where poliomyelitis had previously been regarded as uncommon, the disease was actually acquired by American troops at a far higher rate than at home. In most of these areas sanitation is primitive. Investigation of the areas has revealed that *epidemics* of poliomyelitis in the native population have been seldom recorded, although the prevalence of sporadic cases may not be particularly uncommon.

In areas such as the Middle East and Japan, where the disease is *endemic*, clinical aspects of poliomyelitis differ from those seen in the United States; a much younger age group is involved, and native *adult* cases are almost unknown. In other words, endemic poliomyelitis, as seen among natives in these areas, is comparable to the clinical disease as it existed in Europe, Scandinavia, and the United States prior to 1880.

Strains of poliomyelitis virus collected in North Africa, the Middle East, the Philippines, China, and Japan do not appear to be different from those isolated in the United States, although no adequate immunologic comparisons have been made.

Dielectric Heating

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In the applications of dielectric heating to various industrial processes, alternating frequencies between 1 and 30 megacycles, and rates of temperature rise of 50° F. and upward, are common. The properties of dielectric materials vary widely under these conditions, as must also the magnitude and character of the load on the source of high-frequency power. Methods so far proposed for the measurement of dielectric properties at high frequencies are commonly restricted to low electric stresses and constant temperature, and so are not available for a rapid heating cycle. The present paper describes a calorimetric substitution method for the measurement of power, dielectric constant, loss and power factors over the heating cycles of a well-known industrial process. Interesting variations of dielectric properties are revealed.

The Use of C^{13} and C^{14} in Studying Metabolism in Animals

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Some experiments of our own and others, involving the use of the carbon isotopes C^{13} and C^{14} in aiding to unravel details of fat and uric acid metabolism, are discussed. The theory of beta oxidation of long-chain fatty acids with recombination of the two carbon units to form acetoacetic acid (in liver) is believed to be proved.

Acetate and acetoacetate, products of fat metabolism, were found to be oxidized via the tricarboxylic acid cycle by which carbohydrates are oxidized.

Isotopic lactate, when fed to a phlorhizinized rat, caused a great increase in excretion of glucose although it contributed only a small part of its isotope. Ten per cent of the isotope of the lactate was found in the ketone bodies. Lactate had been changed to ketone bodies without first becoming fat.

Thus, we have shown how both fat and carbohydrate material can enter the metabolic pathways of each other.

Uric acid in pigeons has been shown to be formed from small units, one carbon being furnished by $NaHCO_3$, two others by the carboxyl group of acetic acid or formic acid, and two others by glycine.

Obituary

Willard Lee Valentine

1904–1947

Willard Valentine, eminent psychologist and editor of *Science* since January 1, 1946, died suddenly of a heart attack at his home in Alexandria, Virginia, on Saturday, April 5, 1947. The loss of this able and enthusiastic leader at the age of 42 is tragic. His 17 months of devoted service to the American Association for the Advancement of Science had resulted in noteworthy contributions to the growth and influence of the Association. This brief period seemed to herald great accomplishments for the anticipated full span of years ahead—accomplishments that others must now strive to realize.

In the fall of 1945, Dr. Valentine resigned his professorship and chairmanship of the Department of Psychology at Northwestern University to undertake full-time service as editor of *Science*. He came to this new position with the conviction that the field of scientific publication is second to none as a factor of importance for human welfare. He entered on his new task with eagerness. His ideas were creative and vigorous; he had imagination but was willing to listen to advice and able to avoid being distraught by conflicting opinions. In November and December 1945 he made a thorough study of *Science* as a publication, analyzing its history and achievements and then formulating policies and goals in line with those of the Association. The main objective chosen was to make the journal maximally useful to American scientists and the general public interested in scientific news and advance. The publication was given a more attractive and dignified appearance by discontinuing advertising on the front cover, using more modern type and format, and by rearranging and adapting the magazine sections in line with current interests of the science reading public. The new editor attempted to discourage a content and style which would appeal chiefly to the specialist and endeavored to give preference to papers that presented

evidence of a cooperative attack on some scientific problem common to, or approached through, several specialties.

Valentine was not an armchair scientist nor was he an armchair editor. He undertook the editorship of *Science* as he had pursued science itself—as an experimental program. He had faith that through carefully planned and controlled trials of publishing different kinds of materials in different kinds of ways and by following through with analysis of reader reactions, a scientific basis would be discovered on which sound and creative publication policy could be built and public welfare served.

Three Middle West educational institutions gave Dr. Valentine his scientific training and teaching opportunities. He was born in Chillicothe, Ohio, December 2, 1904. His father was a flour miller, a veteran of the Spanish-American War, following which he was an invalid or at least not a man of robust health for the remainder of his life. It is recalled that Valentine referred to his mother as the chief source of his intellectual and educational stimulation. He entered Ohio Wesleyan University in 1921, receiving the A.B. degree in 1925 and the M.A. degree in 1926. He was assistant in psychology and mathematics, 1925–26, and assistant instructor in psychology, 1926–28, when he received appointment at the same rank at Ohio State University, where he earned his Ph.D. in psychology in 1929. He became assistant professor of psychology at Ohio State in 1929, was promoted to the grade of associate professor in 1932, and continued at this academic rank until 1940, when he became professor and chairman of the Department of Psychology at Northwestern University. During the 11 years following his doctorate at Ohio State, Valentine played a special role in the Department of Psychology as supervisor of beginning courses. Interest in science instruction at the undergraduate level became for him a prevailing passion which greatly influenced his professional career.

His research activities began in 1927 with perceptual studies in audition and vision, conducted on both human and animal subjects. These were excellent pieces of basic scientific work—perhaps his best. His dissertation was prosecuted under the guidance of Floyd C. Dockeray and the late Albert Paul Weiss. The former had been his professor, guide, and mentor at Ohio Wesleyan University. The dissertation, published as a series of three articles entitled "A Study of Learning Curves," presented a large mass of data on maze learning in rats of all ages and was a very comprehensive treatment of maturation in the rat from the standpoint of learning.

A third phase of his research work, and perhaps the most productive one in stimulating later investigation, related to the study of motility in the newborn infant. Dockeray and Valentine collaborated in the development and refinement of an isolation cabinet for infant research. Dr. Weiss had built the first such box, which served as the starting point for this work. With the fully developed equipment a considerable amount of research work was done at Ohio State by a number of graduate students, and the development of this type of investigation did much to advance scientific study of infant behavior.

Valentine's interest in applied psychology came to overshadow his earlier interest in basic research. Effective teaching of science as represented in the teaching of psychology was the objective of this applied interest. With his associate, Dr. Dockeray, he undertook a detailed analysis of the elementary psychology course at Ohio State. The objectives of the course were stated as a series of achievements which could be expected to result from taking the course—achievements such as acquisition of a body of facts and principles of human behavior, understanding of the application of psychological principles to the contacts and problems of daily life, acquisition of a technical vocabulary, development of skills in the application of scientific methods to the problems of human behavior, and the elimination of superstition and misconception concerning human behavior. By means of various examination techniques the extent to which the course was achieving the desired results was thoroughly analyzed. Examination methods were found to warrant careful study. In collaboration with F. E. Wenrick a paper on "Validity of Examinations" was published (1935) which proposed that factual examinations were inadequate.

Several supplementary lines of investigation and development were engaged in by Valentine in his systematic efforts to improve the efficiency of science teaching. He made studies of misconceptions—physicial, biological, social, economic, and psychological—held by college students and examined the effectiveness of college courses in correcting these superstitions. For several years he was chairman of the Committee on Motion Picture Films for Teaching, of the American Psychological Association. He surveyed the colleges and universities of the United States in reference to their use and need for teaching films, helped to write a detailed technical guide on the production of films, and either prepared or was a collaborator in making 11 such teaching instruments. These were described in the psychological literature and made available for all who wished to purchase them. Valentine's first film, entitled "A Trip Through a Psychological Laboratory," presented an integrated series of experiments and demonstrations highly useful for instruction in a beginning course. His *Laboratory manual for psychology* appeared in 1929 and was revised in 1932; *Readings in experimental psychology* was published in 1931; with Taylor, Baker, and Stanton he brought out *Students' guide for beginning the study of psychology* in 1935 and revised it in 1940. Valentine's most important book, *Experimental foundations in general psychology*, was published in 1938 and revised in 1941. In this volume he presented some 19 areas of psychological interest, discussed the research findings in each, and interpreted these findings with emphasis on method and controls as well as on results. Almost 100 selected experimental investigations were thus taken up and reviewed. By this type of treatment he sought to emphasize in the mind of the beginning student that science (psychology) was grounded in, and grew out of, research work.

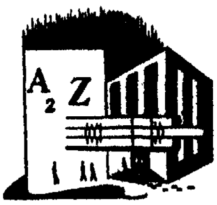
In 1940, when Northwestern University chose a new head for their large Department of Psychology, Valentine was the person selected. Enumeration of the reasons for his selection provides us with a block diagram of Valentine's professional contributions in the field of science. He was chosen head at Northwestern because of his emphasis on research as the foundation of science, his achievements at Ohio State in the improvement of the teaching of psychology, his professional interest in psychological publications, and finally, his demonstrated abilities as business manager and treasurer of the American Psychological Association. The first major task undertaken by the new chairman was that of revising both undergraduate and graduate curricula in order to take into account developments within this scientific field, to make use of the special qualifications of the fairly large staff, and to provide more systematic coverage of the subfields of psychology. The results of these efforts, which tended to unite the Department and build up a team spirit, proved so reasonable and successful as to attract the favorable notice of other departments, which in turn undertook the development of their own curricula along similar lines. In addition, he participated actively in the committees and councils of the University and won enduring respect as a scholar, teacher, and administrator. Thus, two great universities, Ohio State and Northwestern, came to regard him as a leader in science education.

Beginning in 1936 and continuing until his death, Valentine was the efficient and responsible treasurer of the American Psychological Association. In this period the membership increased from 587 members and 1,551 associates to a total considerably in excess of 4,000. From 1937 on, he was business manager of the Psychological Association's scientific journals. There were 5 of these publications when he began this service and 11 at the last. The auditors characteristically reported his accounts in good order; the Association at its annual business meetings, as a rule, readily accepted and approved the budgets he had worked out; and the editors of the several journals valued him as a responsible, cooperative, and congenial business and professional associate. His contributions to the growth and development of this scientific association and its business affairs were indeed very large. To a very wide group of colleagues he was known as "Val" and was valued as a warm and wise friend.

Finally came the opportunity, through the editorship of *Science*, to broaden the horizon and scope of his dearest ambition—the spread of scientific information and thought. Valentine was profoundly challenged and thrilled in being chosen as the successor-editor to James McKeen Cattell and the first editor after *Science* came under full control of the Association. He was ready to give his life with its every skill and ability to this opportunity. And this he did.

WALTER R. MILES

Yale University, New Haven, Connecticut



NEWS
and Notes

Fifty societies will meet with 15 sections of the AAAS at its 114th meeting, to be held in Chicago, December 26–31, 1947. Synopses of section program plans reported by May 21 follow:

R. W. Brink, University of Minnesota, is developing the program of *Section A* (Mathematics) with the assistance of the Executive Committee of the Section, R. L. Moore, University of Texas, and T. R. Hollcroft, Wells College. Four sessions have been planned for the morning and afternoon of December 29 and 30. In addition, a dinner session will be held on the evening of December 29. Arrangements have been made with J. R. Kline, of the American Mathematical Society, to count papers read before the meetings of Section A as having been read before the American Mathematical Society. Paul Dwyer, secretary, Institute of Mathematical Statistics, University of Michigan, has been asked to collaborate in organizing a joint session with the Institute. In general, the program will be devoted to contributed papers. E. P. Lane and R. E. Langer, recent vice-presidents and chairmen of Section A, have been asked to deliver their vice-presidential addresses at one of the sessions.

Section B (Physics) will meet jointly with the American Physical Society on December 29 and 30. "Astrophysics and Nuclear Physics" is the proposed title of one of the sessions, while the other will be in some field of biophysics. The meetings will probably be held on the campus of the University of Chicago. Joseph C. Boyce, New York University, secretary of Section B, is cooperating with Karl K. Darrow, Columbia University, secretary of the American Physical Society, in planning the joint symposia.

The program of *Section C* (Chemistry) is being organized by Ed. F. Degering, Purdue University, secretary of the Section, with the cooperation of the chairman, Farrington Daniels, University of Wisconsin. The sessions, running from December 26 through December 28, will include a joint meeting with the Chicago Section of the American Chemical Society and a series of special symposia arranged by Dr. Daniels, Charles D. Hurd, Northwestern University, and Herbert C. Brown, Wayne University. The subjects will cover "Photosynthesis," "Industrial Processes," and "Mechanisms of Hydrocarbon Reactions." Other sessions will be devoted to general papers. A luncheon for chemists will be held on December 26.

Section D (Astronomy), under the direction of its secretary, C. C. Wylie, University of Iowa, will meet on December 26 and 27. In addition to general papers, a joint symposium has been planned with Section E (Geology and Geography) on the "Origin of the Solar System." Those cooperating with Dr. Wylie in the organization of the program include: D. B. McLaughlin, University of Michigan; George Van Biesbroeck, Yerkes Observatory; Harlow Shapley, Harvard Observatory; S. A. Mitchell, Leander McCormick Observatory; C. M. Huffer, secretary of the American Astronomical Society; and O. J. Lee, Northwestern University, who is acting as the local representative.

Section E (Geology and Geography) will meet on December 26 and 27. The December 26 sessions will center on a symposium entitled "Ground Water Geology and Engineering," organized by E. J. Schaefer, U. S. Geological Survey, Columbus, Ohio. J. Marvin Weller, University of Chicago, is arranging for a symposium on "Mississippian," to be presented on the morning of December 27, and in the afternoon Section E will meet jointly with Section D to discuss the "Origin of the Solar System." George W. White, secretary of Section E, is developing the program with the assistance of M. P. Billings, chairman.

As in past, the *Section F* (Zoology) and *Section G* (Botany) will meet jointly with allied societies. No independent programs have been proposed by either section.

Section H (Anthropology) will also meet on December 26 and 27. The afternoon session on December 26 will be devoted to general papers. On the morning of December 27 the Section will meet jointly with the Linguistic Society of America, through the cooperation of Carl Voegelin, editor of the *International Journal of American Linguists;* the afternoon session will continue the program initiated at Boston last year with a discussion on economic anthropology. This session will be under the chairmanship of Melville Herskovits, Northwestern University. A dinner is planned for the evening of December 26. Marian W. Smith, Columbia University, is secretary of Section H, is in charge of the program.

Harold E. Burtt, Ohio State University, secretary of *Section I* (Psychology), has organized 8 sessions. In a two-day program, contemplated for December 29 and 30, general papers will be grouped according to subject matter. On the evening of the 29th a joint session is planned for the presentation of addresses by Edna Heidbreder, Wellesley College, and W. A. Brownell, Duke University, vice-presidents of Sections I and Q, respectively. Dean A. Worcester, secretary of Section Q, is collaborating in the arrangements for this evening session.

The program plans of *Section K* (Social and Economic Sciences) and *Section L* (History and Philosophy of Science) have not crystallized sufficiently to be reported at this date.

Section M (Engineering) plans to meet December 29 and 30. The present program arrangements, under the direction of the Section secretary, Frank D. Carvin, Newark College of Engineering, call for a series of general technical papers on engineering and a symposium on "Limnological Aspects of Water Supply and Waste Disposal." Theodore A. Olson, School of Public Health, University of Minnesota, will serve as chairman of the symposium, which was organized in cooperation with G. L. Clark, Harvard University, secretary of the Limnological Society of America. The Chicago Technical Societies Council, represented by D. L. Tabern, Abbott Laboratories, is cooperating with Section M in sponsoring the program. J. T. Rettaliata, Illinois Institute of Technology, is chairman of the local committee in charge of meeting details.

Subsection Nm of the Section on Medical Sciences will present a four-session symposium on Antibiotics, December 29 and 30. Malcolm H. Soule, University of Michigan, secretary of the Section, is organizing the program.

Section O (Agriculture) will meet jointly with the American Society for Horticultural Science on December 30, both morning and afternoon. The secretary of Section O, E. E. DeTurk, University of Illinois, has announced that the program will deal in general with the problems of improving the breeding of horticultural crops.

Section Q (Education) will meet on December 29 and 30 for a discussion of the interrelationships of scientific method and social philosophy. D. A. Worcester, University of Nebraska, secretary of the Section, is organizing the panel of participants. On the evening of December 29 Section Q will join with Section I for the presentation of vice-presidential addresses.

About People

Henry Norris Russell, professor of astronomy, and director of the observatory, Princeton University, will retire July 1. Lyman Spitzer, Jr., professor of astrophysics, Yale University, has been appointed director of the observatory, and Martin Schwarzschild, Columbia University, will become professor of astronomy.

Robert M. Muir, instructor in plant physiology at Pomona College, has been appointed assistant professor.

Bela K. Erdoss, associate professor and research associate, Department of Mechanical and Industrial Engineering, Lehigh University, has been appointed director of the new fluid dynamics program, being sponsored jointly by New York University and Stevens Institute of Technology, which opens in September. Dr. Erdoss will also become professor of hydrodynamics at the Institute.

John S. Lawrence, associate professor of medicine, and **Herman E. Pearse, Jr.**, associate professor of surgery, University of Rochester School of Medicine and Dentistry, have been assigned by the Atomic Energy Commission to a 3-month medical study in Japan, in connection with the casualties at Hiroshima and Nagasaki.

A. G. Christie, professor of mechanical engineering, Johns Hopkins University, and **Alfred Iddles**, vice-president and director, the Babcock & Wilcox Company, New York City, were the two official delegates representing the American Society of Mechanical Engineers at the centenary celebration of the British Institution of Mechanical Engineers, June 8–13.

J. A. Rosenkrantz, formerly chief of the Medical Section, Out-Patient Department, Veterans Hospital, Bronx, New York, has recently been appointed chief of the Out-Patient Department.

John R. Paine, formerly professor of surgery, University of Minnesota, has been appointed professor of surgery in the University of Buffalo Medical School and head of the Department of Surgery, Buffalo General Hospital.

Robert Galambos, of Emory University, has joined the staff of the Psycho-Acoustic Laboratory, Harvard University. Dr. Galambos is best known for his work on the ultrasonic 'radar' used by bats in flight and for his successful recording of nerve impulses in single fibers of the auditory nerve.

M. L. Jacobs, acting dean of the School of Pharmacy, University of North Carolina, since the death of J. Grover Beard last year, has been appointed dean by the University trustees.

T. D. Stewart, curator of Physical Anthropology, Smithsonian Institution, has recently returned to Washington from Guatemala, where he has been making a series of physical measurements of living Cakchiquel Indians in the highlands. The Cakchiquel, or "highland Maya," belong to the same racial and linguistic stock as the "lowland Maya," builders of the temple cities of Yucatan in pre-Columbian times. The measurements will be analyzed and compared with similar data on the Yucatan peoples. Dr. Stewart believes that the comparison will reveal notable differences between the Cakchiquel and present-day Yucatan Maya.

Karl Lehmann, professor of fine arts, and director, Archaeological Research Fund, New York University, is en route to Greece to salvage monuments which were uncovered by graduate students of the University before the war, and later desecrated during the Bulgarian occupation. Dr. Lehmann will also arrange for the continuation of the University's archaeological research and excavations on the island of Samothrace.

Arthur H. Compton, chancellor of Washington University, St. Louis, gave the 20th annual Steinmetz Memorial Lecture at Schenectady, New York, May 27, on "The Birth of Atomic Energy and Its Human Meaning." The annual lectures were inaugurated after the death of Charles P. Steinmetz, October 26, 1923, and each year a scientist who has made a notable contribution is selected as speaker.

Kenneth R. MacKenzie, associate professor of physics, University of British Columbia, has been appointed associate professor of physics, University of California, Los Angeles. During the war, Dr. MacKenzie served as research associate in the Radiation Laboratory, University of California, Berkeley.

James T. Barrett, professor of botany and plant pathology, University of California, Berkeley, was honored by colleagues and students June 4 at a dinner commemorating his 34 years on the California faculty, and the attainment of emeritus rank.

Tage U. H. Ellinger, head, Department of Zoology, Howard University, has been appointed chairman, Division of Natural Science, and professor of zoology, Regis College, Weston, Massachusetts.

Visitors To U. S.

V. Prabhaker Rao, entomologist of Bangalore, India, has been sent by his Government to the United States for a year to study our methods of combating the ravages of scale insects in fruit orchards, to investigate American methods of plant quarantine, and to study the classification of scale insects. Three months of this time is being spent at the Natural History Museum, Stanford University, which houses one of the largest collections of scale insects in the world. His classification studies are under the direction of Gordon F. Ferris, of the School of Biological Sciences. From Stanford Dr. Rao will proceed to the Citrus Experiment Station, University of California, and then to various border quarantine stations of the U. S. Department of Agriculture.

W. R. Piggott, of the British National Physical Laboratory, is now visiting the National Research Council of Canada at the invitation of its president, C. J. Mackenzie, and expects to spend some time in Washington, D. C., before his return to England. Mr. Piggott is personal assistant on radio matters to Sir Edward Appleton, permanent secretary of the Department of Scientific and Industrial Research, and is concerned principally with ionospheric work.

J. H. Seddon, of the Wingfield Morris Orthopaedic Hospital, Headington, Oxford, has been invited to the United States to read papers at various medical meetings. He is particularly interested in U. S. work on peripheral nerve injuries and poliomyelitis.

D. W. Wright, of the Horticultural Research Station, Cambridge, is spending several months in the United States and Canada to observe work concerned with insect pests of vegetable crops, insecticides and spraying techniques, and biological control and population studies.

David S. Riceman, agrostologist, Division of Biochemistry and General Nutrition, Australian Council for Scientific and Industrial Research, is making an 8-month tour of U. S. universities to study mineral nutrition of plants.

E. L. Halliday, of the National Physics Laboratory of the South African Council for Scientific and Industrial Research, has recently come to the United States after a visit to England.

Colleges and Universities

The Western Reserve Pharmacy Foundation has launched a nation-wide campaign to raise $528,850 for the purpose of constructing and equipping a new building for the School of Pharmacy, Western Reserve University. This step is the first in a long-range program to expand and improve Cleveland's Medical Center at the University and is directed more specifically toward reducing the critical shortage of trained pharmacists. An estimated 50 per cent more pharmacists will be trained each year.

The Foundation's Executive Committee includes: George Miller, president, Strong Cobb & Company, Inc., chairman; W. G. Leutner, president, Western Reserve University, honorary chairman; Edward Blythin, vice-president, Western Reserve University, treasurer; John C. Levy, Northern Ohio Druggists Association, secretary; William W. Hosler, Strong Cobb & Company, Inc.; Arthur P. Wyss, dean of the School of Pharmacy; and Wendell A. Falsgraf, University trustee.

The University of Chicago's Department of Astronomy will undergo a general reorganization and expansion, according to plans outlined to the Yerkes Observatory staff by Otto Struve, director of the Observatory, and chairman, Department of Astronomy. The plan, which will be effective July 1, 1947, includes the personnel of both the Yerkes Observatory and the McDonald Observatory of the University of Texas. Some of the arrangements proposed by Dr. Struve are: that Gerard P. Kuiper be appointed director of the Yerkes and McDonald Observatories, with W. A. Hiltner continuing as assistant director; that a theoretical section be created under the supervision of S. Chandrasekhar, who will continue to reside at Williams Bay, Wisconsin; that W. W. Morgan be appointed managing editor of the *Astrophysical Journal*, and that the Chicago teaching section be revived under T. L. Page. Dr. Struve, who will guide the new policies and lay the broader plans for the Department, plans to reside at Williams Bay, and at Mount Locke, Texas.

The University of Pennsylvania Museum now houses sections of the oldest known legal code. Samuel N. Kramer, associate curator of the Babylonian Section, and Francis Steele, assistant, discovered the fragments while cataloguing inscriptional material which a University of Pennsylvania expedition to Southern Mesopotamia excavated from the ancient city of Nippur nearly 50 years ago. Written in cuneiform script in the Sumerian language by the Babylonian king, Lipit-Ishtar, its legal doctrines seem, in many instances, to have served as prototypes to the Hammurabi Code (about 1725 B. C.), which until now has been generally recognized as the world's oldest set of written by-laws. A preliminary paper on the contents of the Sumerian code was read by Dr. Steele on April 15 at the annual meeting of the American Oriental Society held in Washington, D. C.

Temple University Research Institute, Philadelphia, has been selected by the Sun Oil Company to complete a research project, begun by the Houdry Process Corporation laboratories, to investigate the causes of metabolic diseases using C^{13} as a tracer. Sidney Weinhouse, who directed the C^{13} project at the Houdry laboratories, will also head the Institute's program. Temple University Research Institute, directed by Gen. D. N. Hauseman, was recently organized to further scientific knowledge at the university level, and to provide research facilities for industrial concerns, associations, and educational institutions sponsoring fundamental scientific research projects.

A new building for metallurgical research development will be erected at Iowa State College with funds allotted by the U. S. Atomic Energy Commission under a general research program. The four-story brick building and equipment will cost $1,000,000. The program, which will be under the direction of F. H. Spedding, head of the Iowa State College Institute for Atomic Research, will continue and expand the work done at the College during the war on the development of processes which proved to be the most efficient methods for producing rare metals. The new building will provide facilities for investigation of all phases of metallurgy, as well as for fundamental research.

Summer Programs

The Institute of General Semantics has announced its 4th Annual Seminar and Workshop, to be conducted by Alfred Korzybski and co-workers at Lakeville, Connecticut, August 16–September 5. It is planned as a fundamental course in general semantics and non-Aristotelian methodology and is intended chiefly for those actively interested in the new methods of evaluation and their applications. The enrollment is limited to 50. Tuition for the three-week period is $150. Further inquiries should be addressed to the Registrar, Institute of General Semantics, Lakeville, Connecticut.

The Naval Research Laboratory has a number of positions open for summer employment in the fields of physics, chemistry, mathematics, electronics, and mechanical and electrical engineering. Monthly salaries of these positions (grades SP-5 and -4) are approximately $200 and $185, respectively. Three and two years of appropriate college study or equivalent experience are required. A limited number of positions at higher grades, of particular interest to graduate students, are also open. Standard Form 57 (Civil Service Commission), required of all applicants, should be sent promptly to: Personnel Office, Naval Research Laboratory, Washington 20, D. C.

Meetings

The International Union of Chemistry has been informed by Director General Julian S. Huxley that UNESCO has provisionally allocated to the Union for the year 1947 the sum of $26,448, approximately $20,000 of which is immediately available as a contribution toward meeting traveling expenses of members of the International Commissions planning to attend the 14th Conference of the Union in London, July 17–23, immediately following the Centenary Celebrations of the Chemical Society of London.

Celebrations of the Chemical Society will be under the presidency of C. N. Hinshelwood. The Conference of the Union will be under the presidency of Marston T. Bogert, professor emeritus of organic chemistry, Columbia University, who has held this position since his election in Rome in 1938. The 11th International Congress of Pure and Applied Chemistry, in association with which the Conference of the Union is to be held, will be headed by the Right Honorable the Viscount Leverhulme as president.

The International Union, a federation of 25–30 countries founded in 1919, has been rebuilt since the close of World War II. The coming Conference will be its first since 1938. Among its eight vice-presidents are Sir Robert Robinson, who recently received the Gold Medal of the Franklin Institute (Science, April 11, 1947), and Alexander Nesmeyanov, director of the Research Institute of Organic Chemistry, National Academy of Sciences, Moscow.

According to information received from Dr. Bogert, the American Chemical Society not long ago set aside a fund of $25,000 for use in paying expenses in this country of foreign chemists and chemical engineers who could not engage in advanced study here without such aid. UNESCO is to designate the individuals who are to receive this support.

The American Mathematical Society will hold its First Annual Symposium in Applied Mathematics at Brown University, August 2–4, on the topic, "Nonlinear Problems in Mechanics of Continua." Major addresses will be delivered by the following: J. J. Stoker, New York University, "Surface Waves in Shallow Water"; F. D. Murnaghan, Johns Hopkins University, "The Foundations of the Theory of Elasticity"; K. O. Friedrichs, New York University, "The Edge Effect in Bending and Buckling With Large Deflections"; and Alexander Weinstein, Carnegie Institute of Technology, "Nonlinear Problems in the Theory of Fluid Motion With Free Boundaries." A number of shorter research papers in the field will also be presented.

Further information may be obtained from Prof. William Prager, Brown University, Providence 12, Rhode Island.

A two-day Symposium on Sound will be held at the Salt Lake Tabernacle and the University of Utah, July 21–22, in connection with the Utah Centennial Celebration. The symposium, which will be open to the public, will include papers by: Harvey Fletcher and Mark B. Gardner, Bell Telephone Laboratories; S. S. Stevens, Harvard University; Vern O. Knudsen, University of California, Los Angeles; Ralph J. Christensen, U. S. Navy Electronics Laboratory, San Diego; Carl F. Eyring and Wayne B. Hales, Brigham Young University; Hillary W. St. Clair, U. S. Bureau of Mines; Alexander Schreiner, Salt Lake Tabernacle organist; and Carl J. Christensen and J. Irvin Swigart, University of Utah.

A Conference on Algebra will be held at the University of Michigan, July 25–28, under sponsorship of the Department of Mathematics. Seven sessions are planned which will feature papers by E. Artin, R. Brauer, S. Eilenberg, N. Jacobson, and S. MacLane. Additional papers on any aspect of algebra may still be submitted. Those wishing to present papers or obtain information about the Conference are invited to write to R. M. Thrall, 319 West Engineering Building, University of Michigan, Ann Arbor, Michigan.

Elections

The Wisconsin Academy of Sciences, Arts, and Letters, at its 77th annual meeting in Milwaukee, April 11–12, re-elected the following officers for 1947–48: L. E. Noland, University of Wisconsin, president; E. L. Bolender, Superior State Teachers College, vice-president in science; Don Anderson, Madison, vice-president in arts; Robert K. Richardson, Beloit College, vice-president in letters; Banner Bill Morgan, University of Wisconsin, secretary-treasurer; H. O. Teisberg, Historical Library, Madison, librarian; W. C. McKern, Milwaukee Public Museum, curator; and L. E. Noland, University of Wisconsin, representative on the Council of the AAAS. Hugo Rohde, Milwaukee, and Samuel Wadmond, Minneapolis, were elected to life membership; Edwin B. Hart, Madison, and Katharine Lenroot, Washington, D. C., to honorary membership.

Robert Marshak, University of Rochester physicist formerly with the Los Alamos Laboratory, has been elected chairman of the Federation of American Scientists. The Washington office of the Federation, located at 1749 L Street, N. W., will continue its operations under William T. Higinbotham, executive secretary, and J. H. Rush, secretary-treasurer.

The New York Section of the American Association of Cereal Chemists, at a meeting on May 6, elected the following officers for the coming year: Henry H. Favor, R. T. Vanderbilt Company, chairman; Louis Bisno, Wagner Baking Corporation, Newark, New Jersey, vice-chairman; and Lawrence Atkins, Wallerstein Laboratories, secretary-treasurer.

The American Society for Clinical Investigation has named Eugene B. Ferris as editor-in-chief of the Society's *Journal of Clinical Investigation*. Dr. Ferris is associate professor of medicine in the University of Cincinnati College of Medicine. I. Arthur Mirsky and William B. Bean, associate professors of experimental medicine and medicine, respectively, at the University of Cincinnati, have been appointed associate editors. As of July 1 the editorial offices will be located in the Department of Internal Medicine, Cincinnati General Hospital.

The Medical Division, Army Chemical Center, Edgewood Arsenal, Maryland, has openings for toxicologists, experimental pathologists, and biophysicists, with salaries to range up to $8,179.50 per annum. Inquiries should be addressed to Chief, Civilian Personnel Division, Edgewood Arsenal, Maryland.

Vincenza Porrini, Laboratorio D'igiene e Profilassi, Provincia di Firenze, Firenze (Florence), Italy, would greatly appreciate receiving unwanted or extra copies of the *Journal of Bacteriology* and other journals dealing with the laboratory sciences.

COMMENTS *by Readers*

A paper by F. H. J. Figge (*Science*, March 28, p. 323) states some new and interesting results on the biological effects of cosmic radiation. The problem is a complex one, and possibly a physicist may properly call attention to a few of the pertinent physical considerations.

Most of the radiation reaching sea level consists of mesotrons (*Rev. mod. Phys.*, 1939, 11, 122–296), some of which are extremely penetrating. Indeed, small residual intensities have been detected as far down as instruments have been carried. Thus, it cannot be stated exactly what thickness of absorber is necessary to reduce the intensity to zero, for some slight intensity is found to be present under matter equivalent to 300 feet of lead. Presumably, about a mile underground the intensity will be so low as to be immeasurable with present apparatus. It is true, however, that a few feet of lead will materially reduce the radiation at sea level.

At higher altitudes the intensity is much greater, for the atmosphere constitutes a barrier equivalent to about 3 feet of lead. At an altitude between 18,000 and 19,000 feet, depending on local conditions, half the atmosphere is below the observer. At 30,000 feet he has only about a third remaining above him, and at 60,000, only a tenth. Indeed, at the latter elevation the total intensity of the radiation is about 100 times the sea level value, the exact amount depending on the latitude and on the surrounding material, for any biological specimen would require a considerable amount of surrounding matter to survive at 60,000 feet. The intensity at most of our cities at high altitudes in the West is 4 or 5 times the sea level value. At La Paz, Bolivia, where over 100,000 persons live at elevations of between 11,000 and 13,000 feet, and at the mines, such as Morococha, Peru, where the whole community lives at nearly 15,700 feet, the radiation may approximate 10 times the sea level value. The word "approximate" is essential, for the effect of surrounding material is considerable. High-altitude mines, where tunnels provide place for controls subject to much-reduced radiation, would appear to be the ideal location for experiments on biological effects of the radiation. The intensity at each station would have to be determined, in order to enable the effect of surrounding matter to be assessed, but this measurement is fortunately not difficult.

Figge correctly cites the effect of lead plates in providing concentrated matter in which shower production is accentuated, so that below these plates there is more intensity than above, providing that by intensity one means a flux, or number of rays per square centimeter per second. If one means energy, then the statement is not true, for the total energy below the lead plate is less than that above by the amount of the energy absorbed in the lead. Thus, below the plate there are more particles, but each has a lower energy than those above. Biologists might find that the low-energy rays are more effective biologically than high-energy rays, for they are, on the average, more ionizing and lose more energy—and perhaps have more biological effect—per centimeter of path through the specimen.

The effect of surrounding matter is of the greatest importance. The astonishment on the face of a colleague who brought a cosmic-ray shower counter indoors and noted the considerable increase in number of showers indoors will always be a lesson in point. Inside a complex structure like a building, conditions are not uniform and in general not calculable, but again the intensity is readily measured.

Neutrons and protons are produced (S. A. Korff and E. T. Clarke. *Phys. Rev.*, 1942, 61, 422) by the cosmic radiation. The number, energy distribution, and subsequent history of these particles depends on the altitude and on surrounding matter. Possibly these particles may contribute to biological effects.

Finally, a word should be said about normal radioactive contamination. Often half the total ionization produced at sea level is produced by local contamination. Unfortunately, local radiation varies from place to place and from day to day, depending on meteorology and other factors. Even if a biological specimen received no cosmic radiation, it is another problem to shield him from local rays. Local radiation can be reduced to a low value by a 10-cm. lead shield, but in the case of biological experiments this shielding is never complete, due to contamination of the specimen, his food, the container, and the air. If such radiation can penetrate a few centimeters of lead, it can certainly also produce some biological effects, and this would have to be taken into account. Again, the amount of local contamination is readily measured.

The results of the experiments reported by Figge are interesting and important and should be continued. Techniques exist whereby the intensity, either in flux or in energy, of the radiation can be measured, as can the amount of local contamination. Possibly this has already been done, but it was not so stated in the paper, and without this additional information it is hard to evaluate the results, or even to be certain that the results were attributable to cosmic rays and not to local contamination. (S. A. Korff, *New York University*.)

Chromatographic studies showing the presence of α-aminobutyric acid and methionine sulfoxide in urine have been reported in a recent communication by C. E. Dent (*Science*, March 28, p. 335). The quantity of these metabolites excreted was increased after methionine administration; hence it was concluded that they were derived from methionine. The fact that methionine can be oxidized to the sulfoxide *in vivo* and, under certain conditions *in vitro*, leads him to question the validity of analytical procedures for the determination of methionine in urine by oxidation reactions (H_2O_2, etc.).

As the author of such an analytical procedure (A. A. Albanese, J. E. Frankston, and V. Irby. *J. biol. Chem.*, 1944, 156, 293), the writer was naturally deeply concerned about this last suggestion and undertook to check his procedure in order to ascertain whether, in fact, aeration of the urine under these conditions would result in a loss of methionine by oxidation. It was found that prolonged aeration for 24 hours caused no appreciable reduction in the methionine content of urines or solutions of pure dl-methionine. The fear expressed by Dent would thus appear to be unwarranted. (Anthony A. Albanese, *New York University College of Medicine*.)

TECHNICAL PAPERS

B-Glucuronidase Activity of the Blood and Tissues of Obstetrical and Surgical Patients[1]

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The enzyme β-glucuronidase hydrolyzes a large variety of conjugated glucuronides. Its function *in vivo* is believed to be the catalysis of glucuronide conjugation (*1*). In previous work, its relation to the metabolism of the estrogens has been demonstrated (*4*). In humans, glucuronides of the estrogens and their derivatives are excreted in the urine. The process of glucuronide formation should not be regarded necessarily as a detoxication mechanism but as one of "metabolic conjugation" (*2*).

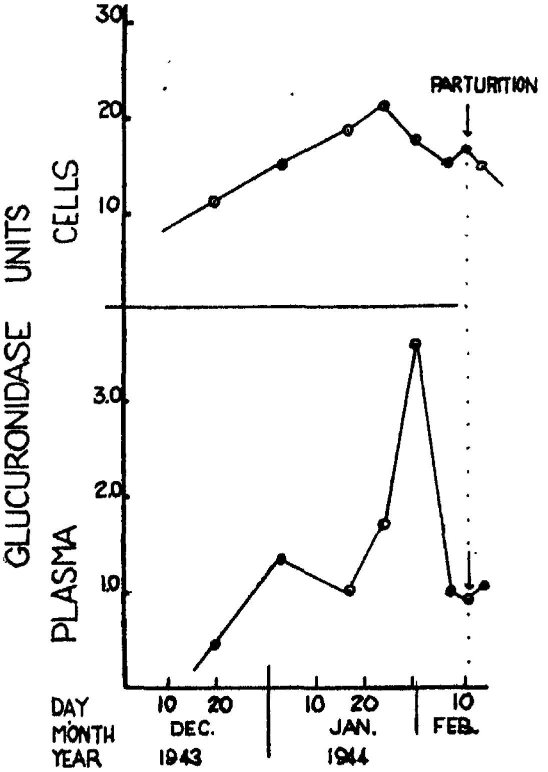

Fig. 1. Alterations in the β-glucuronidase activity of the blood of one patient as related to the last trimester of pregnancy and parturition. A glucuronidase unit here is defined as 1 mg. of glucuronic acid liberated from menthol glucuronide per hour at 38° per 100 cc. volume under standard conditions (*1, 2*).

Conjugated estrogens are excreted in large amounts during pregnancy. Since β-glucuronidase appears to be involved in the conjugation of the steroid hormones, its activity was studied in the blood cells and plasma in the various stages of human pregnancy. The following observations were made on the 30 women studied.[2]

As in most humans, there is a much greater concentration of the enzyme in the blood cells as compared with the plasma. However, the enzyme activity in the cells increases as pregnancy progresses and remains elevated for a short period after parturition. In the plasma, the enzyme shows peaks of increased activity and usually drops to normal levels after parturition. An example of the alterations in blood glucuronidase with pregnancy is shown in Fig. 1. While this study was in progress, it was noted that in one case there was a high plasma glucuronidase associated with early toxemia. These preliminary observations suggest that the study of the blood glucuronidase in a large number of women may lead to a better understanding of the process of gestation and may also yield data of diagnostic value.

TABLE 1*

Patient	Pathological diagnosis		Units† of glucuronidase activity			
			Tissue		Blood	
	Lesion	Organ	Tumor	Normal	Cells	Plasma
M.	Carcinoma	Breast	900	94	260	145
R.	"	"	1,930	62	579	118
K.	Fibroadenoma	"	393	325	563	150
K.	Carcinoma	Esophagus	1,510	750	1,098	278
B.	"	"	2,160	650	399	187
L.	"	Stomach	3,180	940	1,155	236
V.	"	Colon	900	1,930	200	266
O.	"	"	1,360	1,760	448	228
M.	"	"	5,250	2,490	633	91

* These data are taken from work in progress, which is being done in collaboration with A. J. Anlyan. The full publication will appear at a later date.

† One unit is defined as 1 μg. of phenolphthalein liberated from phenolphthalein mono β-glucuronide per hour at 38° from 1 gram of moist tissue or from a 100-cc. volume of cells or plasma under standard conditions (*3,5*).

Since mammary tumors have been induced in animals by the prolonged administration of estrogens, it seemed desirable to study the β-glucuronidase activity of various tumor tissues obtained at operation. Wherever possible, the corresponding uninvolved tissue was also assayed. Plasma and blood cell glucuronidase were determined before operation. Some of the data are given in Table 1.

It is clear that in carcinoma of the breast the tumor contains from 10 to 20 times as much enzyme as the uninvolved

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[1] Aided by a grant from the Otho S. A. Sprague Memorial Institute.

[2] The cooperation of Richard Forman is gratefully acknowledged. These patients were studied with the permission of the Department of Obstetrics and Gynecology, Bowman Gray School of Medicine, Winston-Salem, North Carolina.

breast tissue. No difference from normal was noted in the case of the benign fibroadenoma. In carcinoma of the gastrointestinal tract an elevated concentration of the enzyme is apparent in 4 of 6 patients.

From these few cases there seems to be no correlation of the blood glucuronidase with the incidence of cancer. However, one may speculate as to the reason for the relatively high glucuronidase activity in mammary tumors. Since glucuronidase activity has been found associated with the action of the estrogenic hormones (*4*), this suggests the accumulation of significant amounts of sex hormone in the mammary tumor. In cancer of the gastrointestinal tract, the question arises as to whether or not excessive amounts of estrogen may be present, in view of the elevated glucuronidase content.

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Relabeling of the Cis and Trans Isomers of 1,3-Dimethylcyclohexane

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Evidence pointing to the necessity of relabeling the cis and trans isomers of 1,3-dimethylcyclohexane has been recently presented (*6*). The pertinent experimental facts may be summarized as follows: (a) The 1,3-dimethylcyclohexanes were synthesized by Skita and Schneck (*7*), who prepared a mixture of the cis and trans isomers by hydrogenating m-xylene, and who identified for the first time the lower-boiling and higher-boiling isomers as the trans and cis isomers, respectively, according to von Auwers' rule (*8*), and analogous to the isomers of 1,2-dimethylcyclohexane and 1,4-dimethylcyclohexane. (For these isomers, the lower-boiling one also has a lower refractive index and lower density.) (b) The low-temperature measurements of Oliver, Todd, and Huffman (*6*), coupled with values of the standard entropies of vaporization (*2*), yield experimental values for the standard entropy in the gaseous state at 25°C. such that, for the cis and trans isomers, the lower-boiling isomer has a standard entropy lower than that of the higher-boiling isomer by about 1–1.5 cal./deg. mole, in each of the three pairs, 1,2-dimethylcyclohexane, 1,3-dimethylcyclohexane, and 1,4-dimethylcyclohexane. (c) The energies of isomerization reported by Prosen, Johnson, and Rossini (*6*) for the gas state at 0° K are such that the three lower-boiling isomers have an energy content near 2 kcal./mole less than that of the corresponding higher-boiling isomer. (d) The data (*3*) giving the relative amounts of the cis and trans isomers formed in the hydrogenation (in the range 200°–250°C.) of each of the three xylenes show that the lower-boiling isomer is in each case the more abundant, the relative amounts being in accord, within the combined limits of uncertainty, with the values calculated (*4*) thermodynamically from the experimental entropies and heats of isomerization. The foregoing experimental facts are consistent in indicating a lower energy content, lower entropy, lower density, and lower refractive index for the lower-boiling isomer of the cis- and trans-1,2-, 1,3-, and 1,4-dimethylcyclohexanes.

It is also a matter of experimental fact that, among pairs of geometric isomers, the one possessing less steric hindrance has the lower energy content and usually has the lower boiling point, lower density, and lower refractive index. Various complex situations give exceptions to this rule. If the molecular configuration is such as to produce less steric hindrance in the trans isomer, the latter will normally have the lower boiling point, lower energy, etc., and the cis isomer will normally have the higher boiling point, higher energy, etc. This is the situation in the monoolefins (such as cis- and trans-2-butene) and in the cis- and trans-1,2-dimethylcyclopentanes, in which cases the trans isomer is the lower-boiling, etc.[1] In these cases, the name trans is synonymous with less steric hindrance.

But in the case of the cis and trans isomers of the 1,2-, and 1,3-, and the 1,4-dimethylcyclohexanes, Pitzer and Beckett (*6*) have shown that the trans configuration is not uniformly associated with the isomer of less steric hindrance. As has already been explained in detail by Pitzer, Beckett, and Spitzer (*6*), substantially all the molecules of cyclohexane are in the "chair" or symmetrically staggered configuration in which the successive CH_2 groups comprising the ring are alternately twisted up and down from a plane passing through the ring of carbon atoms. The result is that 6 of the hydrogen atoms lie in an equatorial belt extending out from the ring of carbon atoms, while the remaining hydrogen atoms are perpendicular to the plane through the ring of carbon atoms, three being above and called north polar, and three being below and called south polar. Of the 6 hydrogen atoms which are "cis" to one another, three may be described as north polar and three as equatorial. Of the two hydrogen atoms on each carbon atom, one is polar and one equatorial. If the 6 carbon atoms are all twisted through a single plane over to the opposite chair configuration, all hydrogen atoms originally polar become equatorial and vice versa. With this situation, there thus exists among the 1,2-, the 1,3-, and the 1,4-dimethylcyclohexanes two tautomeric forms for each isomer. Considering only the tautomeric form of lower energy in each case where the energies are different, the trans-1,2-, the cis-1,3-, and the trans-1,4-dimethylcyclohexanes each have both methyl groups equatorial, while the cis-1,2, the trans-1,3, and the cis-1,4-dimethylcyclohexanes each have one methyl group equatorial and one polar. Changing one methyl group from an equatorial to a polar position leads to an increase in the steric hindrance in the molecule and a consequent increase in its energy.

The statistical calculations (*6*) lead to values of the standard entropy lower for trans-1,2-, cis-1,3-, and trans-1,4-, respectively, than for cis-1,2-, trans-1,3-, and cis-1,4-dimethylcyclohexane. The analysis of the molecular structure also indicates that, in each pair (cis and trans), the isomers of lower energy should be trans-1,2-, cis-1,3-, and trans-1,4-dimethylcyclohexane. Furthermore, the calculated values of these differences agree quantitatively with the experimental values within experimental error. The statistical and molecular structure calculations, therefore, lead to the necessity of relabeling the cis and trans isomers of 1,3-dimethylcyclohexane.

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[1] See, however, G. Chiurdoglu (*Bull. Soc. Chim. Belg.*, 1944, **53**, 45), who has concluded, on the basis of rates of reaction, that in the 1,2-dimethylcyclopentanes, the cis isomer is the lower-boiling. We are not inclined to regard this type of evidence as at all conclusive.

Since preparing this manuscript, we have belatedly come upon the work of Mousseron and Granger (*5*), which seems also to have been overlooked by others. Mousseron and Granger prepared the cis and trans isomers of 1,3-dimethylcyclohexane from appropriate optically active starting materials and found the optically active isomer, which must be trans (*6*), to be the higher-boiling member of the pair. This completely confirms the conclusion presented above.

For these reasons, a change has been made, as of March 31, 1947, in the naming of the cis and trans isomers of 1,3-dimethylcyclohexane in the tables of physical and thermodynamic properties and in the catalogues of spectrograms issued by the American Petroleum Institute Research Project 44. The change is such that the lower-boiling isomer, formerly labeled "trans," is now labeled "cis," and the higher-boiling isomer, formerly labeled "cis," is now labeled "trans."

The following notation will be used in the tables and catalogues of spectrograms listing these compounds:

cis-1,3-Dimethylcyclohexane.[2]

trans-1,3-Dimethylcyclohexane.[3]

In addition to the foregoing changes in connection with the work of the American Petroleum Institute Research Project 44, corresponding changes have been made in the work of the American Petroleum Institute Research Project 6 and in the cooperative program on standard samples of the National Bureau of Standards and the American Petroleum Institute.

All workers in other laboratories dealing with cis-1,3-dimethylcyclohexane or trans-1,3-dimethylcyclohexane are invited to relabel these two compounds in the manner described above. It is also recommended that, whenever either of the two names is written, one or more properties also be recorded for adequate identification apart from the name cis or trans. This latter step will completely eliminate any confusion which may arise from this relabeling.

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[2] This isomer, formerly labeled "trans," has the following properties (*1*): boiling point at 1 atm., 120.09°C.; refractive index, n_D at 25°C., 1.4206; density at 25°C., 0.7620 g/ml.

[3] This isomer, formerly labeled "cis," has the following properties (*1*): boiling point at 1 atm., 124.45°C.; refractive index, n^D at 25°C., 1.4284; density at 25°C., 0.7806 g/ml.

The Dark Reductions of Photosynthesis[1]

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Although green plants have been shown (*4*) to fix CO_2 in the dark, the conditions influencing that fixation and the compounds formed were unknown. We are investigating these variables.

The conditions of the experiments were as follows: A sample of actively growing algae was split into two parts (approximately 1 cc. algae/15 cc. suspension). One part (I) was kept in the dark, exposed to 4 per cent CO_2 in N_2 for about 8 hours. The other (II) was exposed to the light of a 150-watt tungsten lamp (.7 g.cal./cm.^{2}/min.) for one hour, during which time it was kept free of CO_2 by constant flushing with N_2. The two samples were then evacuated, kept in the dark, and simultaneously exposed to the same gas containing $C^{14}O_2$ in N_2 for a period of 5 minutes. At the end of this period, the algae were killed by an acetic acid-HCl mixture and the remaining active $C^{14}O_2$ pumped off.

The total nonvolatile radiocarbon content of the two samples was then measured and its chemical distribution determined. The preliminary results are given in Table 1.

From these results alone, it is clear that the reduction of CO_2 to sugars and the intermediates in that reduction does not involve the primary photochemical step itself. This is further substantiated by the appearance of an appreciable fraction (up to 15 per cent) of the radiocarbon in the methylene groups of the succinic acid isolated from sample I of the table (*3*). It is thus confirmed that the photochemical process establishes a reservoir (small, to be sure) of reducing power which can subsequently carry out all of the reduction steps necessary to bring CO_2 to sugar.

TABLE 1

DARK FIXATION OF CO_2 BY *Chlorella*

Pretreatment	I CO_2 in the dark	II Light in the absence of CO_2
Total (relative units)	1	5.5
Succinic acid*	70%	6%
Fumaric acid	3%	1%
Malic acid	—	6%
Cationic substances† (not extractable by ether from pH 1—probably amino acids)	15%	30%‡
Anionic substances† (not extractable by ether from pH 1)	9%	10%
Neutral (sugars)	<.1%	1.5%
Unidentified (extractable by ether from pH 6)	2%	6%
Unidentified (extractable by ether from pH 1)	—	25%

* The succinic acid was isolated without carrier and identified by extraction coefficient, equivalent weight, C and H analysis, melting point, and X-ray powder pattern.

† Absorbed by Duolite ion exchange resins C-3 and A-3, respectively.

‡ Largely alanine.

Using some of the reactions already established in animal tissue and bacteria (*5*), it is possible to account for the above results as well as the observed distribution of radiocarbon in sugar produced by a short photosynthesis (*1*).

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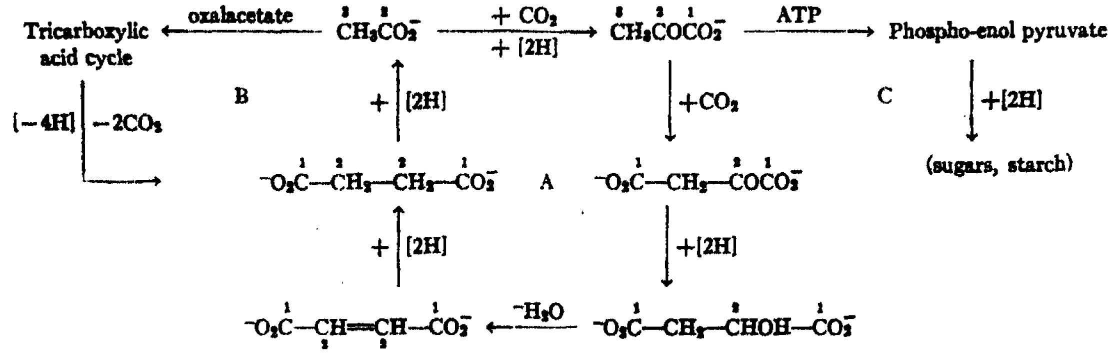
[1] This paper is based on work performed under Contract #W-7405-Eng-48 between the Atomic Energy Commission and the University of California.



Starting with either acetate or pyruvate, the numbers over each carbon atom indicate which carbon atoms are labeled each time around cycle A. The reducing power (indicated as [2H]) is, of course, ultimately derived from the light reaction, and some of it might well be reduced coenzymes I or II. The high-energy phosphate required in these reductions is not explicitly shown in the chart. All or part of it could easily be derived from the combustion of part of the acetate through cycle B.

It should be mentioned that this scheme cannot be a simple reversal of the respiratory system of reactions, since CO_2 derived from respiration of barley leaves (*2*) containing freshly photosynthesized radioactive sugars has a lower specific activity (per mg. C) than the sugar itself. If respiration involves some of the same intermediates as those shown in the chart, the respiratory system must be physically separated from the photosynthetic system.

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IN THE LABORATORY

The Oxalate Salt of P-Aminodimethylaniline, an Improved Reagent for the Oxidase Test

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The cultural method for the diagnosis of gonococcal infection, now a standard procedure (*1*) in most public health laboratories, utilizes the so-called "oxidase test" for rapidly distinguishing colonies of the *Neisseria* from non-oxidase-producing colonies of other genera. The oxidase reaction is considered to depend upon the reaction of an oxidative enzyme with an aromatic amine to produce a series of readily discernible color changes ranging from pink to black.

The dye component heretofore recommended for the oxidase test is the monohydrochloride salt of p-aminodimethylaniline. On standing, this agent deteriorates and becomes discolored, thereby reducing its solubility and the clarity of its aqueous solutions. The precipitate which forms interferes with the separation of oxidase-positive from oxidase-negative colonies in mixed cultures.

Because the oxalic acid salts of aromatic amines are, in general, more stable than the corresponding hydrochloride acid salts, the oxalate salt of p-aminodimethylaniline, $[H_2NC_6H_4N(CH_3)_2]_2 \cdot (\text{—COOH})_2$,[1] was tested for its suitability in the oxidase reaction.

Observations were made on the rapidity with which the dry, crystalline oxalate salt deteriorated at temperatures ranging from 18° to 23° C. One per cent aqueous solutions of the monohydrochloride and of the oxalate salt were compared in the oxidase reaction on chocolate agar plates inoculated with cultures of *N. gonorrhoeae*, with mixed cultures of *N. gonorrhoeae*, streptococci, and diphtheroids, and with cervical and urethral exudates for evidence of gonococcal infection.

A comparative study of the stability of 1 per cent aqueous solutions of each compound was made at temperatures of from 18° to 23° C. Measurements of the oxidative changes in the two dye salts were made at 24, 48, and 72 hours after preparation of the solutions, using a Klett-Summerson colorimeter.

The toxicity of 1 per cent aqueous solutions of the two salts was tested on recently isolated strains of the gonococcus.

The dry, crystalline oxalate salt was more stable than the monohydrochloride salt. After 6 months storage at room temperature in amber bottles, no visible change was noted in the crystalline oxalate, whereas pronounced darkening occurred in the monohydrochloride salt. Aqueous solutions of the former could also be maintained for longer periods with less discoloration and precipitation. Furthermore, after standing 48 hours under the above conditions, less precipitation was noted in the aqueous solutions of the oxalate salt than in those prepared from the monohydrochloride salt. Comparative readings with a Klett-Summerson colorimeter showed that the solution of the oxalate salt needed to stand for 72 hours in order to give a reading equivalent to the 24-hour reading of the monohydrochloride solution, thus indicating that the rate of decomposition of the oxalate salt was approximately one-third that of the hydrochloride salt.

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[1] P-aminodimethylaniline oxalate was prepared and supplied by the Research Laboratories of the Eastman Kodak Company, Rochester, New York.

The toxicity of 1 per cent solutions of the two salts for the gonococcus was similar. Seventy-five per cent of the strains tested were viable after 5 minutes in either solution.

A slight disadvantage of the oxalate salt, however, was the relatively slower rate at which it went into solution in water at room temperature. This could be hastened by gentle heating.

Reference

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Histochemical Method for the Detection of Phosphorylase in Plant Tissues[1]

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Since its discovery in 1939 (*1*), phosphorylase has been found to occur in a number of plant species (*2*). It catalyzes the reversible reaction, starch + phosphate $\rightleftharpoons$ glucose-l-phosphate (Cori ester). The importance of this enzyme in plant physiology is obvious. It represents the first synthesis, *in vitro*, of starch, the most important product of the plant kingdom. A histochemical method for its detection is highly desirable, since knowledge about its distribution and localization would be very helpful in studying the physiology of starch formation in plants.

The success of a histochemical method depends primarily on the formation of an insoluble, stainable reaction product specific to the enzyme. Obviously, neither glucose-l-phosphate nor the phosphate ion can be used in the present case because of their diffusibility, the difficulty of their detection, and complications due to other enzymatic reactions (e.g. phosphatase). Starch, however, answers all the requirements. The question resolves itself, therefore, into finding a plant tissue which is free, or can be made free, from starch.

In an investigation in one of our laboratories[2] it has been observed that soybean contains no detectable amount of starch until one to two days after germination. A histochemical method for phosphorylase can, therefore, be easily devised with this material.

Soybean (*Glycine Max Merr.*) soaked for 12 hours in water was cut into free-hand sections 10–20 μ thick. The sections were incubated at 25°C. in a medium consisting of 1 per cent glucose-l-phosphate in a buffer saturated with toluol. Acetate buffer at pH 6 was generally used. Sections were taken out at frequent intervals and stained with iodine in potassium iodide.

Starch grains can be observed in some parts of the soybean section after 30–60 minutes of incubation, indicating the presence of phosphorylase.[3] That the formation of starch is due to phosphorylase and not to other factors (e.g. phosphatase and amylase) is proved by the facts that (1) no starch can be found until more than 12 hours of incubation if glucose instead of glucose-l-phosphate is used in the medium; (2) no effect is produced by the presence in the medium of M/200 sodium fluoride, which completely inhibits the activity of phosphatase (*3*); and (3) boiled sections give no reaction.

Using the time of appearance of starch and its abundance as a measure of phosphorylase activity, it has been found that, in the soaked soybean, the most intense reaction is located in the rootcap,[4] a less intense reaction is observed in the root tip and the lateral buds, still less in the young leaves, stem tip, and hypocotyl, and the least in the cotyledons.

Starch formation in intact germinating soybean has also been studied, and its relation to the distribution of phosphorylase will be given later in a more detailed report.

The present method is by no means limited to starch-free plant tissues such as soybeans. Most plant tissues can be deprived of starch by keeping them in darkness for a certain length of time. Geranium (*Pelargonium zonale Ait.*) leaves starved for two days in the dark, for example, show a strong phosphorylase reaction in the mesophyll cells after incubation with glucose-l-phosphate.

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1. Hanes, C. S. *Nature, Lond.*, 1940, **145**, 348.
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3

Use of Aerosol OT in Dissecting Salivary Glands of Mosquitoes Infected With Malaria

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When mosquitoes are dissected in an aqueous medium such as physiological saline, extreme annoyance and difficulty are often experienced because of the tendency of the insects to float on top of the solution and the dissected parts to adhere to the dissecting needles. Since immersing the mosquitoes in ethyl alcohol does not always overcome this difficulty, another surface-tension reductant was sought which would insure thorough wetting of the mosquito and yet not damage the sporozoites which might be present in the salivary glands.

A method frequently used for dissections in this laboratory consists of anesthetizing the mosquitoes, removing them to a Syracuse watch glass, placing a drop of 70 per cent ethyl alcohol on each insect, filling the watch glass with distilled water, and finally transferring each mosquito to a drop of physiological saline on a microscope slide for dissection.

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[1] This work was started in Kunming, the wartime University site, and was continued in Peiping.

[2] Unpublished results of the Physiology Laboratory, Agriculture Institute, National Tsinghua University, Kunming.

[3] A statement by J. B. Sumner (*Cornell Extension Bull.* 668, 1945) that "soybeans lack phosphorylase" (p. 17), refers perhaps to dormant beans.

[4] Phosphatase activity is strongest in rootcap of grains, according to Glick and Fischer (*Arch. Biochem.*, 1946, 11, 65–79).

The method followed in testing new agents was to immerse the anesthetized mosquitoes in the test solutions and then transfer them, in a drop of the same material, to a slide for dissection.

Preliminary trials were made, employing in turn (1) isoamyl alcohol, (2) capryl alcohol, (3) ethyl acetate, and (4) Aerosol OT (dioctyl sodium sulfosuccinate). The first three compounds were discarded because, in the concentrations used, their immiscibility with water made detection of sporozoites difficult. Aerosol OT, however, seemed to possess the desired properties and was, therefore, examined further.

A 1:100 stock solution of Aerosol OT was made by adding 100 ml. of distilled water to 1 gram of Aerosol OT and allowing it to stand overnight at room temperature. Working solutions were made from this stock by subsequent dilution with physiological saline (0.85 per cent NaCl solution).

As a result of a series of observations using both *Aëdes aegypti* infected with *Plasmodium gallinaceum* and *Anopheles quadrimaculatus* infected with *P. vivax*, a 1:60 dilution with physiological saline of the 1:100 aqueous stock Aerosol OT solution (final dilution of Aerosol OT, 1:6,000) was ultimately found to be optimal.

In order to determine whether the 1:6,000 Aerosol OT solution has a deleterious effect on the sporozoites, the viability of sporozoites from mosquitoes wet and dissected in this solution was compared with that of sporozoites from mosquitoes wet in 70 per cent ethyl alcohol and dissected in saline. *A. aegypti* infected with *P. gallinaceum* were used. Twenty chicks, about one week old, were divided into 4 groups of 5 each. Each chick was injected subcutaneously with the infected salivary glands from one mosquito. The first group of 5 chicks (A) received the infected glands immediately after the glands were dissected in Aerosol OT. The second group (B) was inoculated with infected glands which had been dissected in Aerosol OT and allowed to remain in that medium at room temperature for 15 minutes. Two control groups (C and D) were inoculated with infected glands dissected in physiological saline. Chicks in group C received the glands immediately after dissection, while those in group D were inoculated with the glands which had remained in saline at room temperature for 15 minutes.

All of the chicks in group A showed infection on the 11th day; of those in group B, three showed infection on the 11th day, one on the 13th, and one on the 18th. All of the chicks in the control groups, C and D, with the exception of one which died early in the experiment, exhibited parasites on the 11th day.

In a similar experiment using a 1:4,000 dilution of Aerosol OT, the infections in the groups dissected in Aerosol OT were delayed, only three chicks in groups A and B exhibiting parasitemia by the 36th day. All of the chicks in the control groups showed infection by the 9th day.

These experiments establish the fact that a 1:6,000 dilution of Aerosol OT is a good wetting agent for mosquitoes; the insects can be dissected easily, and if sporozoites are present in the salivary glands, they are readily detected. However, it appears to have a deleterious effect on sporozoites of *P. gallinaceum*, and should be used with caution when the sporozoites of this or other species are to be used for producing infections.

A Quick Method for Filling Curved Glass Apparatus With Liquids

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The usual technique of filling certain types of glass apparatus with a liquid requires the tedious and time-consuming procedure of immersing the apparatus first in hot water and then in cold, the apparatus being connected to the liquid when it is placed in the cold water. This procedure must be repeated many times, and much difficulty is usually experienced in disposing of the last air bubble.

A simple and quick way to accomplish the task is to thread two small, flexible plastic tubes through the curved glass tubing to the top of the apparatus (the plastic being nonsoluble in the liquid used). The tubing can be passed around bends more easily by repeated short thrusts associated with a twisting motion than by steady pressure. Each plastic tube is then connected to a needle of appropriate size, attached to a large syringe. One syringe is used for instillation of the liquid, and another for the concomitant aspiration of air. After filling the glass apparatus, the plastic tubes are carefully removed.

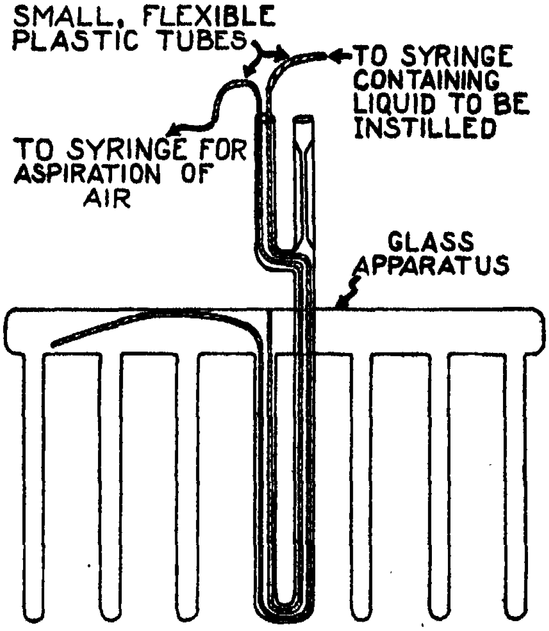
SMALL, FLEXIBLE PLASTIC TUBES
TO SYRINGE CONTAINING LIQUID TO BE INSTILLED
TO SYRINGE FOR ASPIRATION OF AIR
GLASS APPARATUS

Fig. 1

Using polyethylene tubing furnished by Suprenant Electrical Insulation Company, a glass apparatus designed for use as a thermoregulator was completely filled with toluene in a period of 10 minutes (Fig. 1).

The described technique is of especial value when the layering of solutions is necessary or volatile liquids are being used.

Book Reviews

Elsevier's encyclopaedia of organic chemistry. Vol. XIV: ***Tetracyclic and higher-cyclic compounds***; Series III: ***Carboisocyclic condensed compounds.*** E. Josephy and F. Radt. (Eds.) New York-Amsterdam: Elsevier Publishing Co., 1940. Pp. xx + 736. $60.00; to subscribers of Series III, $52.50; to subscribers of complete work, $45.00.

This new *Encyclopaedia of organic chemistry,* of which Volume XIV is the first to appear, is to be a complete survey of all organic compounds together with their chemical, physical, and physiological properties. It is to be printed in English. Since this series of volumes contemplates the coverage of the literature in a manner somewhat similar to Beilstein, a comparison is pertinent.

The physical and chemical data under any individual compound are less extensive, and the arrangement of references, though space conserving, is less convenient than in Beilstein. Abstract journals have sometimes served as source material for the Elsevier publication; the original literature always, in the case of Beilstein.

Volume XIV is well printed and more readable than Beilstein. The inclusion of numerous structural formulas is advantageous, and the presence of subject and formula indexes will be very helpful. The assembly of the work on tetracyclic and higher-cyclic compounds includes the sterols and many other types of molecules not now appearing in Beilstein. This publication deserves a place in any good chemical library.

Whether Elsevier has adopted a classification which will be preferable to that of Beilstein and whether it will be possible to complete this series by 1962 and then keep it up to date within 10 years remains to be determined. Organic chemists will eventually decide the relative merits of the two publications based on their day-to-day experience with them.

ROGER ADAMS

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The chemistry of commercial plastics. Reginald L. Wakeman. New York: Reinhold, 1947. Pp. xii + 836. (Illustrated.) $10.00.

It is some 12 years since the well-known treatise, *Chemistry of synthetic resins,* was published by Ellis. In the preface to the present book, the author states that he makes "no pretense of being encyclopedic in the sense of Ellis" and that "little or no consideration has been given to innumerable journal articles and patents which are not rather directly reflected in current commercial operations." However, he does "attempt to be selective to information particularly pertinent to industrial practice."

In these words the author states both the strength and weakness of the text—strength, because the selection is a natural one, based on sound current commercial considerations; weakness, because the text is dated with no hint that changes have already taken place and that pertinent information is now available in the patent literature. As the writer states in the conclusion, "Daily a new resin is born, a striking application created or a novel process of fabrication perfected." Since any of these announcements are usually first printed in the Official Gazette of the U. S. Patent Office, it is obvious that such recent products and developments are not mentioned. Moreover, a better acquaintance with the patent literature would have allowed much better "guesses" as to the chemical constitution of many plastic compositions.

The book is divided into 26 chapters, the mean chapter length being approximately 30.5 pages. It is perhaps significant that the subject treated most closely to the mean length is that on the new developments in "Contact Resins." The longest chapter (88 pp.) covers "Vinyl Resins," whereas the shortest disposes of the "Aryl Sulfonamide-Formaldehyde Resins" (3 pp.). Other longer chapters include: "The Mechanical Manipulation of Plastics," "Phenolic Plastics," "Alkyds and Allied Resinous Esters," "Polystyrene," "Acrylic Resins," "Natural and Synthetic Elastomers," and "Cellulose Plastics." Although the writer leans heavily on technical data supplied by the sales divisions of various plastic manufacturers, his judgment is not warped by this information, nor is the reader swamped with details on various competitive products. Pertinent references are appended to each chapter. These references, as indicated, are notably free of patent citations, but the general selection of technical information and trade reports is noteworthy. The treatment is comprehensive, from a description of the coating of Noah's ark to a one-page section on miscellaneous German wartime developments.

In any text of this type a good index is almost mandatory. This book contains complete trade names, author, and subject indexes, comprising 3½, 6, and 30 pages, respectively.

EDWARD L. KROPA

American Cyanamid Company,
Stamford, Connecticut

Scientific Book Register

CULVER, CHARLES A. *Musical acoustics.* Philadelphia-Toronto: Blakiston, 1947. Pp. xiv + 215. (Illustrated.) $3.00.

MORTON, C. V. *The American species of Hymenophyllum section Sphaerocionium.* (Contributions from the U. S. National Herbarium, Vol. 29, Part 3.) Washington, D. C.: Smithsonian Institution, 1947. Pp. viii + 62. $.30.

NATHAN, DAVID S., and HELMER, OLAF. *Analytic geometry.* New York: Prentice-Hall, 1947. Pp. x + 402. $3.50.

SCHELL, IRVING I. *Dynamic persistence and its applications to long-range foreshadowing.* (Harvard Meteorological Studies, No. 8.) Cambridge, Mass.: Harvard Univ. Press, 1947. Pp. 80. (Illustrated.)

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The Chemical Study of Penicillin:

A Brief History

The Editorial Board of the Monograph on the Chemistry of Penicillin

DURING THE DECADE FOLLOWING the discovery of penicillin (*1*) relatively little information was secured as to its chemical nature. Fleming had reported it to be soluble in water and in alcohol, but insoluble in ether or chloroform, and its thermal stability in solution to be maximal at neutrality. Three years later Raistrick and his collaborators (*2*) found that penicillin could be produced in a synthetic medium. They also showed that when solutions of penicillin at pH 7.2 were extracted with ether, some of the antibacterial activity was transferred to the ether, but that when the process was carried out at pH 2, the extraction was almost complete. They likewise noted that the antibiotic extract was sensitive to oxidants and was readily inactivated by evaporation in acid and alkaline solution, but moderately stable at pH 5–6.

After a further interval of three years Raistrick's findings were confirmed, in general, by Reid (*3*), who found, in addition, that the activity was lost on dialysis and that penicillin was adsorbed on charcoal.

In 1940 Chain, Florey, and their collaborators (*4*) prepared penicillin in solid, though inhomogeneous, form and reported on its effectiveness *in vivo* against various pathogenic organisms. In the same year Abraham and Chain (*5*) described the preparation from *B. coli* of an enzyme, penicillinase, which inactivates penicillin. In 1941 the Oxford workers (*6*) published details of a procedure for the concentration of penicillin from culture fluid obtained with the use of Raistrick's synthetic medium. This involved extraction from acid solution with organic liquids and further purification by chromatographic procedures. In this way there was secured (*7*) the barium salt of an acid which proved to be stable when absolutely dry or in organic solvents.

In 1942 Abraham and Chain (*8*), by further refinements of the process, succeeded in producing a barium salt with an activity of 450–500 units/mg. This product was later found (*9*) to contain nitrogen, but the provisional formula suggested, $C_{24}H_{32}O_{10}N_2Ba$, was soon found to be incorrect. One impurity detected was barium furoate. The significance of the nitrogen content was indicated by its linear relation to antibiotic potency. On hydrolysis this substance yielded carbon dioxide, a volatile acid, and the crystalline salt of a base. The authors recognized that their material was not homogeneous, so that these data could not be interpreted with certainty. It was also observed (*10*) that penicillin is inactivated by primary alcohols, by organic bases, and by various metallic salts—for example, those of copper and zinc.

The basic compound, referred to above, received the name penicillamine; it was shown (*11*) to be a primary amine and to contain one strongly and one weakly acidic group. The hydrochloride was at first assigned the formula $C_5H_{11}O_4N \cdot HCl$ and, later, $C_5H_{11}O_2SN \cdot HCl$. In so far as the Oxford work was concerned, the recognition of sulfur in penicillin (see below) followed directly from the study of an oxidation product of penicillamine. The analytical results indicated the uptake of three oxygen atoms and thus suggested conversion of a thiol to a sulfonic acid. The significance of penicillamine as an integral part of penicillin became obvious when it was obtained from penicillin having an activity of 1,000 units/mg. on the Oxford scale of that date.

In the meantime the study of penicillin was taken up in other laboratories. A product showing 750 units/mg. was obtained at the Imperial College of Science, London (*12*), where it was observed that penicillin, on degradation, yielded a product which appeared to be an amino acid. The conversion of penicillin in acid solution into a crystalline product termed penillic acid was recorded early in 1943 by chemists in the Wellcome Research Laboratories (*13*). In the United States, penicillin was obtained in the form of a crude ammonium salt (*14*), which had an activity of 240 units/mg. (*15*), but no evidence was presented as to its chemical nature.

On treatment with diazoalkanes, penicillin concentrates were found to yield esters which proved to be notably more stable than the salts. They showed little activity *in vitro*, but were antibiotically active *in vivo*. The benzhydryl ester was split by catalytic hydrogenation with regeneration of *in vitro* activity (*16*). It was later shown that the methyl and ethyl esters could be hydrolyzed to active penicillins by treatment with sodium hydroxide or sodium bicarbonate solution (*17*, *18*).

By 1943 recognition of the potential military importance of penicillin had led to restriction of chemical information on the subject. Investigation was continued with increasing intensity, in both academic and industrial research laboratories, but, in general, the results were privately communicated to other recognized workers in the field rather than to the scientific press. This exchange

From Chapter I of the monograph entitled *The chemistry of penicillin*, now in preparation under the supervision of the National Academy of Sciences and the Office of Scientific Research and Development, to be published by the Princeton University Press.

of information on the chemistry of penicillin was effected in Britain at first through unofficial conferences of interested workers and later by those sponsored by the Ministry of Supply and the Medical Research Council. There were also special agreements between certain pharmaceutical manufacturers in England (especially May and Baker, Ltd., one of the firms which entered the Therapeutic Research Corporation of Great Britain, Ltd.) and in the United States (Merck & Co., Inc., E. R. Squibb & Sons, and subsequently Chas. Pfizer & Co., Inc.). Information secured by the American firms was subsequently communicated to the Committee on Medical Research and disseminated through it; a similar procedure was followed in England, where the five firms participating in the Therapeutic Research Corporation, as well as Imperial Chemical Industries, Ltd., and various academic groups, reported to the Medical Research Council.

During the first half of 1943, progress in the chemical studies was made principally in Britain, where, in addition to penicillamine, 2-pentenylpenillic acid and 2-pentenylpenillamine were isolated as conversion products of the impure preparations then available. Experimental work in the United States was at first primarily directed toward problems of production and purification. It was found in the Northern Regional Research Laboratory and in the Merck and Squibb laboratories that chromatographic procedures, the efficacy of which had been demonstrated in Britain for the concentration of penicillins in the form of their free acids, could be applied advantageously to the more stable sodium salts. The partition chromatography of Martin and Synge was adapted for the purification and separation of the penicillins by chemists of Imperial Chemical Industries, Ltd. In the summer of 1943, MacPhillamy, Wintersteiner, and Alicino, of the Squibb group, succeeded (*19*) in crystallizing the sodium salt of benzylpenicillin. This important achievement, which made possible the accurate chemical study of the pure compound, immediately led to the recognition by the same investigators of sulfur as a constituent of the molecule. Coincidentally, the presence of sulfur in (impure) barium penicillin, as well as in penicillamine, penicillaminic acid, penillic acid, and other well-defined derivatives of penicillin, was discovered independently by the chemists in Oxford (*20*). Soon afterward the Oxford workers reported the crystallization of alkali metal salts of their penicillin.

At about the same time it became clear that the penicillin which had been obtained in crystalline form in the United States was not identical with the penicillin with which the British investigators had been working. Among other differences between the two was the far greater reluctance of the latter to crystallize. The chemical distinction between them was clearly brought to light during the middle of 1943 by observations in several quarters. One was the demonstration by Stodola, Wachtel, and Coghill, of the Northern Regional Research Laboratory, that the two varieties of penicillin give different, though analogous, crystalline derivatives when the free acids of the respective penicillins are treated with benzylamine. The second observation was the demonstration in the Merck laboratories, by analytical data on crystalline penillic acids, that there were at least two penicillins.[1] The American preparations had been found (*21*) to yield phenylacetic acid on hydrolysis, whereas the antibiotic studied in Britain yielded 2-hexenoic acid under similar conditions (*22*). Very convincing evidence was also obtained by the chemists of Imperial Chemical Industries, Ltd., at an early stage of the development. The main constituents of their own penicillin and of Merck penicillin were chromatographically separated (*23*). This was later confirmed by direct comparison of the derived penillic acids (*24*). It appears that these reports had a limited circulation.

On the other hand, penicillamine having the same configuration was obtained from both types. After some uncertainty as to its constitution (*20*), penicillamine was recognized by the Oxford workers to be β,β-dimethylcysteine. This was demonstrated by chemical (*25*) and crystallographic comparison with a synthetic sample (*26*). Penicillamine had in the meantime been shown to yield thiazolidines on condensation with carbonyl compounds, and it was suspected that the same ring system was present in the penicillin molecule (*27*). Grounds for this suspicion had been furnished by the observation (*28*) that when the Oxford penicillin was decomposed by mercuric chloride, it yielded a carbonyl compound, probably an aldehyde, as well as penicillamine. This aldehyde was characterized in the form of a crystalline 2,4-dinitrophenylhydrazone and a condensation product with dimedone, and was shown to have the composition $C_8H_{13}O_2N$ (*27*). It was recognized as hexenoylaminoacetaldehyde and as the source of the glyoxal-osazones which were obtained early from mother liquors resulting after hydrolysis and separation of penicillamine. Meanwhile the Imperial College of Science group (*29*) had shown that the antibiotic studied in Britain could be reduced to a dihydro derivative which was biologically active and was recognized as a "natural" penicillin. It afforded n-caproic acid on hydrolysis. The position of the double bond in the hexenoic acid obtained from the unreduced antibiotic was determined at Oxford by permanganate oxidation to propionaldehyde. The Imperial College workers found that the penilloaldehyde from their dihydropenicillin afforded a dinitrophenylhydrazone which could be further changed to the glyoxal osazone. They therefore suggested that the aldehyde was n-caproylaminoacetaldehyde. In both series the identity of the penilloaldehydes was confirmed by synthesis.

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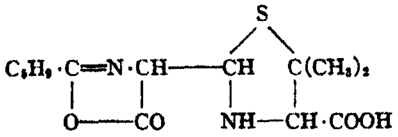
[1] Systems of nomenclature using letters (in the United States) and Roman numerals (in Britain) were initiated late in 1943. However, in the interests of clarity and uniformity, workers in the field agreed early in 1946 on the nomenclature now in use, which involves a designatory prefix such as "benzyl."

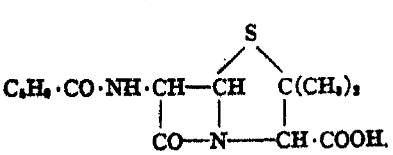
Analogous conclusions and hypotheses were attained independently and simultaneously by American workers. The chemists in the Squibb Institute (*30*) and in the Merck laboratories (*31*) produced evidence that the carbonyl compound secured by treatment of the American crystalline penicillin with mercuric chloride was phenylacetylaminoacetaldehyde. It was, for example, found to be oxidized to phenaceturic acid. At the same time the Merck group demonstrated that when the product formed by the action of benzylamine upon benzylpenicillin was treated with mercuric chloride and penicillamine was liberated, the benzylamine group remained in amide linkage in the residual portion of the molecule. A strictly analogous result was obtained with the methyl ester which resulted from the action of methanol upon benzylpenicillin. It was also shown by members of the Imperial Chemical Industries group (*32*) that the methyl ester of pentenylpenicillin, on treatment with mercuric chloride, yielded the methyl ester of penicillamine. The identity of the acid group in penicillin with the carboxyl group of penicillamine was thus definitely established by two independent methods.

In the recognition of degradation products of penicillin, invaluable aid was rendered by X-ray crystallographic measurements. For instance, the 2,4-dinitrophenylhydrazone of the penilloaldehyde secured in Oxford was shown by this method (*33*) to be identical with the hydrazone prepared from synthetic 2-hexenoylaminoacetaldehyde (*34*).

On the basis of these and many other findings, the Oxford workers proposed (*35*) the thiazolidine-oxazolone formula



as the simplest expression for their penicillin. An exactly corresponding formula was independently proposed for benzylpenicillin by the Merck, Squibb, and Abbott groups. However, the chemists in both the Oxford and the Merck laboratories drew attention to the fact that the presence of a basic group, indicated by this structure, could not be detected in penicillin, and both proposed, as a possible alternative, the β-lactam structure



At this point it was hoped that, as the penicillins were relatively simple compounds, synthetic methods for their production could be developed without much difficulty. The urgency of the need for large quantities of penicillin by the military forces made imperative the intensive exploration of this field on a wider front and on a basis of international collaboration. At the instance of the director of the Office of Scientific Research and Development and the chairman of the Committee on Medical Research in Washington, D. C., and the secretary of the Medical Research Council in London, the necessary diplomatic agreements were reached. The American group of collaborators was enlarged by the inclusion of 8 more industrial research laboratories and 10 academic laboratories.[2] Contracts between these organizations and the governmental agencies were entered into, according to the terms of which each contractor undertook to conduct experimental investigations in connection with the chemical structure of penicillin and the synthesis of penicillin or a therapeutic equivalent. All contractors undertook to report to their Government all pertinent information available to them at that time and thereafter to furnish monthly progress reports.[3] All of this information was transmitted as expeditiously as possible to each contractor in Britain and in the United States. In the United States the contracts, which began during December and January 1943–44, remained in force until November 1, 1945 in the case of the industrial organizations[4] and December 31, 1945 in the case of the academic institutions. In Britain, as already stated, the early collaboration was an informal by-product of a Penicillin Production Committee, sponsored by the Ministry of Supply. On January 1, 1944, the Medical Research Council set up a Committee on Penicillin Synthesis (CPS) under the chairmanship of Sir R. Robinson and including representatives of the industrial groups, academic centers, and the Ministry of Supply. The regular exchange of British and American reports then began, but because of delay in the first months much work was duplicated. Attention is drawn elsewhere to the more important consequences of this situation.

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[2] The following groups collaborated in the general program: In America, the industrial participants were Abbott Laboratories; Cutter Laboratories; Heyden Chemical Corporation; Eli Lilly and Company; Merck & Co., Inc.; Parke, Davis and Company; Chas. Pfizer & Co., Inc.; Shell Development Company; Squibb Institute for Medical Research; The Upjohn Company; Winthrop Chemical Company, Inc. The academic and governmental participants were U. S. Department of Agriculture, Northern Regional Research Laboratory; Cornell University Medical College, Department of Biochemistry, and Russell Sage Institute; Federal Security Agency, Food and Drug Administration; Harvard University, Department of Chemistry; University of Illinois, Department of Chemistry; University of Michigan, Departments of Chemistry and Physics; National Bureau of Standards; Naval Medical Research Institute; The Rockefeller Institute for Medical Research.

In Britain the industrial participants were Boots Pure Drug Company, Ltd.; British Drug Houses, Ltd.; Glaxo Laboratories, Ltd.; Imperial Chemical Industries, Ltd. (Alkali Division); Imperial Chemical Pharmaceuticals, Ltd.; May and Baker, Ltd.; Wellcome Foundation, Ltd. The academic and governmental participants were Cambridge University, Departments of Chemistry and Colloid Science; Imperial College of Science, London, Department of Organic Chemistry; The London Hospital Medical Unit; Manchester University, Department of Chemistry; National Institute for Medical Research, Hampstead, London; Oxford University, Department of Crystallography, Dyson Perrins Laboratory, Sir William Dunn School of Pathology, and the Department of Physical Chemistry.

[3] Arrangements have been made for the deposition of a complete file of these reports with the U. S. Department of Commerce, Office of Technical Services, from which reproductions of desired portions can be obtained on request. Copies of these reports are also being filed in scientific libraries in Britain.

[4] The industrial participants in the chemical projects performed the subject work of their contracts without financial aid from their Governments. In both countries, however, grants were made to the academic groups in support of their work.

The unrestricted exchange of current information at frequent intervals resulted in as close a collaboration as is possible among a widely distributed group of laboratory teams, but no attempt was made to avoid duplication of effort in the various laboratories. In consequence it is difficult or impossible, except in a relatively few specialized phases of the joint effort, to assign sole scientific credit for individual findings secured during the period covered by the contracts.[5] In the outline that follows no attempt is made to do more than touch upon some of the more significant results.

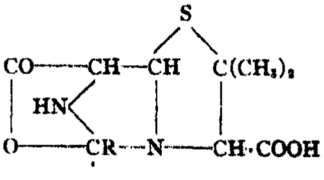
In the winter of 1943–44, an important problem was the confirmation and clarification of the structure assigned to penicilloic acids, the primary product of the hydrolysis of penicillins. The major part of the light thrown on this problem was supplied by the Merck laboratories. The D (or "unnatural") configuration of penicillamine was established by successive treatment with phenylisocyanate and with Raney nickel catalyst, whereby the sulfur atom was replaced by hydrogen; the product was identical with the phenylureide derivative of D-valine (*31*).

As stated in *Science* (*36*), the constitution of the penaldic acid, with which penicillamine is combined in benzylpenicilloic acid, was established (*31*) by its conversion on catalytic hydrogenation into cyclohexylacetylalanine. Under less drastic conditions of hydrogenation corresponding derivatives of serine were obtained. As these amino acid derivatives were optically inactive, they yielded no information as to the configuration of that part of the penicilloic acid molecule. This information was secured only later, when it was shown in the Merck laboratories (*37*) that under suitable conditions of hydrogenation derivatives of L-alanine, which has the "natural" configuration possessed by the amino acids of proteins, were formed.

Derivatives of penaldic acid were synthesized in several laboratories by the condensation of ethyl formate or orthoformate with esters of phenylacetyl glycine, and when the products were condensed with synthetic D-penicillamine, esters of penicilloic acids were obtained. In a very complete study, in the Merck laboratories (*38*), methyl esters of three of the four theoretically possible diastereoisomers of the penicilloic acids derived from D-penicillamine were synthesized, and it was shown that at least two of these were formed by the action of methanol upon benzylpenicillin. Somewhat later, esters of the fourth isomeric form of penicilloic acid were synthesized in the Squibb Institute (*39*).

It has already been mentioned that the conversion of penicillins into penillic acids contributed largely to the recognition of the existence of more than one variety of penicillin. The constitution of benzylpenillic acid was confirmed by synthesis in two laboratories during 1944. An optically inactive monomethyl ester was prepared by Cook, Elvidge, and Heilbron (*40*) by condensing the methyl ester of phenylthioacetyldiethoxyalanine with DL-penicillamine. The dimethyl ester of optically active penillic acid, identical with the product from benzylpenicillin, was synthesized by the Merck group (*41*) by condensing the Schiff base from N-formyl-α-formylglycine methyl ester and benzylamine with the methyl ester of D-penicillamine.

Attempts, made in many laboratories, to produce penicillins by anhydrization of penicilloates met with almost universal failure. It is worthy of note, however, that they did provide the first synthetic material possessing antibiotic activity, even though the potencies were small and not proved to be of penicillin type (*42*). In the early stages of the research, the oxazolone, or azlactone, structure indicated above was that to which most attention was paid, but, as the work progressed, increasing difficulty was experienced in applying it to the penicillins. This was especially the case in connection with the physicochemical investigations such as the electrometric studies by Neuberger (*43*) and many others. A number of structures which had been proposed at the outset were excluded, during the first half of 1944, by the observation that the penicillin molecule contains only one labile hydrogen atom other than that of the carboxyl group. This was indicated in the Abbott laboratories by the action of Grignard reagent upon methyl benzylpenicillinate (*44*) and at Cornell University by equilibration of sodium benzylpenicillinate with deuterium oxide (*45*). The structural limitations thereby imposed were met by the formulas set forth above, as well as by a tricyclic formula



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[5] Shortly after the contracts between OSRD and the industrial participants had expired, a brief summary announcement of the principal findings was published in *Science* (*36*) and in *Nature* (1945, **156**, 766). At a conference, attended by scientific representatives of all the cooperating groups, held on January 9, 1946, it was decided that detailed reports of the results secured under the collaborative program should, in general, be published in a monograph rather than in individual papers in the scientific press. However, provision was made for the publication, in advance of the monograph, of papers which, in the opinion of the Editorial Board, would not conflict with the plan. Several such articles have appeared.

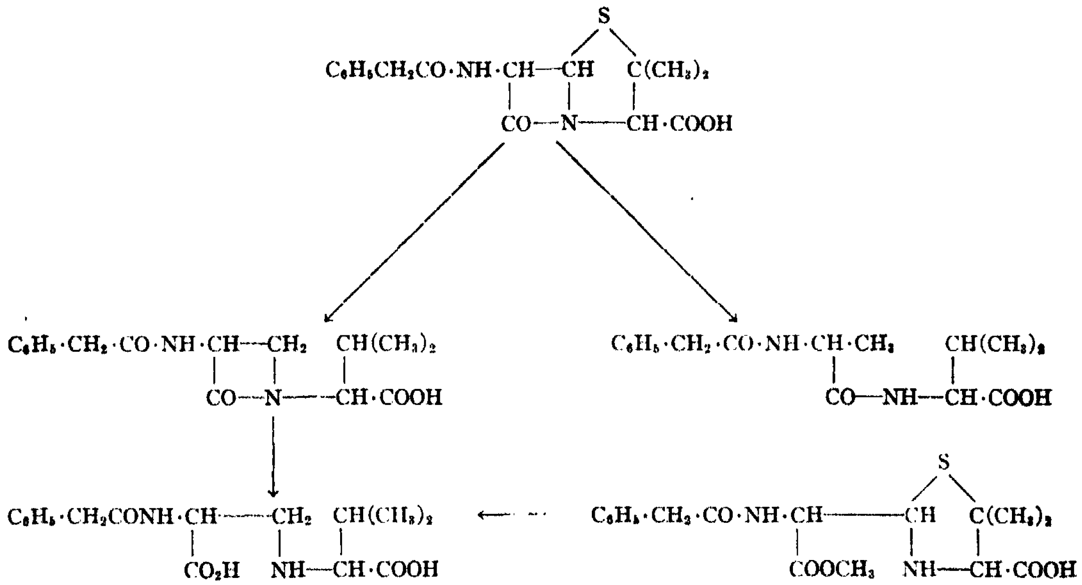
When the monograph was planned, it was hoped that its writing could be completed in six months; unfortunately, this estimate proved unduly optimistic.

which had been proposed by several of the participant groups.

Among these alternatives, the β-lactam structure gradually gained popularity. This formula received support from physicochemical evidence. Infrared absorption spectra were studied principally by the Shell Development Company; Thompson, of Oxford University; Sutherland, of Cambridge University; Randall and collaborators, of the University of Michigan; Merck & Co., Inc.; and the Russell Sage Institute, Cornell University Medical College. An important result was the demonstration by the Shell Development Company of the presence in penicillins of a distinctive absorption band which also appeared in three models containing a fused β-lactam-thiazolidine structure, prepared in its laboratories. Also, other absorption bands found in the spectrum of penicillin were considered to indicate the presence of a monosubstituted amide group. The models here show that the bands extend over a certain range and that the penicillin band is on the margin of this range. Thus, the amide group is perhaps present in a modified form.

Thermochemical data, secured by the National Bureau of Standards and interpreted by Woodward, of Harvard University, suggested the presence of a strained system in penicillin, comparable with that of authentic β-lactams. More cogent still, the CNOS skeleton of the penicillin molecule was conclusively demonstrated through the X-ray crystallographic analysis of sodium, potassium, and rubidium benzylpenicillins by Crowfoot and Low (Oxford University) and by Bunn and Turner-Jones (Alkali Division, Imperial Chemical Industries, Ltd., Northwich). The existence of the β-lactam ring was first shown clearly in electron density projections derived from all three salts in February and March 1945; it was later fully confirmed by the evaluation of the electron density in three dimensions for the sodium and potassium salts alone. The detailed arrangement of the atoms found in these salts determined not only the essential chemical formula but also the stereochemical relations between the different groups within the penicillin molecule. X-ray spectrum determinations, made by Clark and his group at the University of Illinois, contributed greatly to our knowledge of the various penicillins and their derivatives.

From the standpoint of organic chemistry, the most convincing evidence was secured by a study, carried out in the Merck laboratories (*46*), of the action of Raney nickel catalyst upon sodium benzylpenicillinate. Two products resulted; one was benzyldesthiopenicillin, a monocarboxylic acid $C_{16}H_{20}O_4N_2$, which on hydrolysis yielded D-α-benzyldesthiopenicilloic acid, identical with the product of the action of Raney nickel catalyst on α-methyl D-α-benzylpenicilloate; the other was a monocarboxylic acid $C_{16}H_{22}O_4N_2$, identified with phenylacetyl-L-alanyl-D-valine (see formula given directly below).


S
C₆H₅CH₂CO·NH·CH—CH C(CH₃)₂
CO—N——CH·COOH
C₆H₅·CH₂·CO·NH·CH—CH₂ CH(CH₃)₂
CO—N——CH·COOH
C₆H₅·CH₂·CO·NH·CH·CH₃ CH(CH₃)₂
CO—NH—CH·COOH
C₆H₅·CH₂CONH·CH——CH₂ CH(CH₃)₂
CO₂H NH—CH·COOH
S
C₆H₅·CH₂·CO·NH·CH——CH C(CH₃)₂
COOCH₃ NH—CH·COOH

As sodium benzylpenicillinate, when similarly treated in the absence of Raney nickel catalyst, underwent no loss of antibiotic activity or change in optical rotation, it may be assumed that these products were formed without intramolecular rearrangement.

In studies of the interaction of thiocyanate and benzylpenicillin, begun in October 1944 and carried on throughout 1945 in the laboratories of Cornell University Medical College and the Squibb Institute, it was found that whereas azlactones in general yield 2-thiohydantoins, penicillin does not do so, but resembles an authentic β-lactam, studied by the Merck group (*47*), in yielding a thiohydrouracil. Although the oxazolone and β-lactam structures would give a common intermediate with thiocyanate, the results of this intricate investigation may be considered to support the lactam structure. The properties of the sulfur atom in penicillin were also found to accord with this hypothesis. Thus, methyl benzylpenicillinate affords a sulfone (*48*) and a sulfoxide (*49*). Hence, penicillin behaves like an acylated thiazolidine (*50*), in contrast to unacylated thiazolidines, in which the ring is opened on oxidation.

During the period in which the penicillin molecule was considered to contain the oxazolone (azlactone) ring, many attempts were made to synthesize penicillin-like compounds by condensing appropriate alkoxymethylene oxazolones with penicillamine. Experiments conducted in the Merck laboratories (*51*) showed that a trace of antibiotic activity corresponding to benzylpenicillin could be produced by this general method. It was independently found in Oxford (*52*) that a similar small degree of antibiotic activity was produced in a reaction designed to yield an artificial "styrylpenicillin." The work was extended to other cases including propyl-, *n*-amyl-, benzyl-, and phenylpenicillins, and similar antibiotic activity was obtained. The chemists of May and Baker, Ltd., also condensed 2-phenyl-4-ethoxymethylene oxazolone with DL-penicillamine in pyridine solution and obtained an antibiotic product (*53*). It was later shown by the Oxford workers (*54*) that this activity was destroyed by penicillinase, and it was therefore attributed to a compound of the penicillin type. Support for this interpretation was supplied by the Cornell group, who showed (*55*) that the mixture of the reaction products formed in the condensation of 2-benzyl-4-methoxymethylene-5(4)-oxazolone with penicillamine exhibited the same quantitative relationships in its antibiotic activities toward a series of 7 microorganisms as did pure benzylpenicillin. Evidence strongly suggestive of identity was also secured by the Cornell workers, using the isotope dilution method (*56*).

Attempts to concentrate the antibiotically active product synthesized by the method described a year earlier by the Merck group met with only partial success; chromatographic procedures used by the Upjohn chemists (*57*) and countercurrent distribution technique used at Cornell (*58*) led at best to preparations containing less than 3 per cent and 17 per cent of penicillin, respectively.[6] Although this method of synthesis was based on the thiazolidine-oxazolone structural theory, it must be pointed out that a rational synthesis of the β-lactam structure by way of the oxazolone is conceivable as the result of intramolecular acylation.

Concurrently with the studies of structure, the search for other penicillins was carried on in several laboratories. The principal accomplishments in this line of endeavor were proof of the existence of p-hydroxybenzylpenicillin by the isolation of the corresponding penillic acid and related compounds in the Imperial College of Science (*59*), followed by the isolation of the antibiotic itself in the Northern Regional Research Laboratory (*60*), of n-heptylpenicillin in the Abbott Laboratories (*61*), of flavacidin (probably 3-pentenylpenicillin) from *Aspergillus flavus* in the Squibb Institute for Medical Research (*62*), and the production at the Northern Regional Research Laboratory of halogenated penicillins and aryl azopenicillins by the action of halogens and of diazo compounds upon p-hydroxypenicillin (*63*).

A development of great technical importance resulted from the observation, first recorded by the Northern Regional Research Laboratory (*64*), that the addition of phenylacetic acid and related compounds to media in which penicillin is elaborated in surface culture gives rise to increased yields of antibiotic products. Attempts to induce a similar effect with submerged cultures having failed, the chemists of the Lilly Research Laboratories, in an extensive survey, discovered (*65*) that the yields of penicillin could be raised by the addition of phenylacetyl derivatives of various L-amino acids. It was shown that a strain of *P. notatum* which had hitherto not been observed to produce any antibiotic but 2-pentenylpenicillin actually produced benzylpenicillin when grown in presence of phenylacetamide (*66*); in presence of p-hydroxyphenylacetic acid a yield of p-hydroxybenzylpenicillin much higher than any isolated in previous fermentations was obtained. This was a clear indication of biosynthesis (*67*). Extension of this principle to analogous compounds, in which the benzyl group of the phenylacetamino acids was replaced by a wide variety of other groups, led to the production and isolation in pure, crystalline form of many novel penicillins (*68*).

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[6] At this point the contracts expired; the investigation, continued by the Cornell group as an independent project, led to the isolation, early in 1946, of synthetic benzylpenicillin in crystalline form. An account of the background and results of this work, together with full references, was, at the request of the Editorial Board of the monograph on the chemistry of penicillin, published in November, 1946 (*Science*, 1946, 104, 431).

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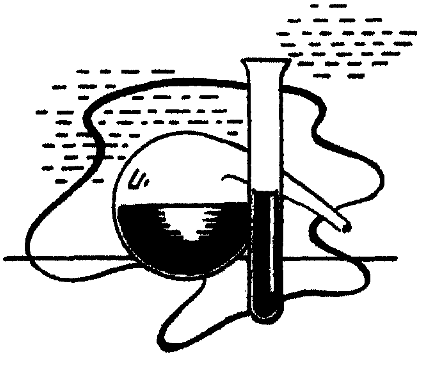

NEWS *and Notes*

A part of the annual exhibition of the Photographic Society of America has, for the past two years, been devoted to a section showing scientific and technical photographs. At the 1946 meeting of the Association more than 200 such prints were hung in the section, and about 50 of these were selected and made available to technical societies, camera clubs, etc. This year the annual meeting and exhibition will be held in Oklahoma City. Readers of *Science* who wish to submit prints for the technical section should secure complete information from W. F. Swann, 343 State Street, Rochester 4, New York. The final date for receipt of prints is September 8. Subject matter for the section may cover any phase of technical photography except pictorial photographs of technical and mechanical operations. Both black-and-white and color photographs are acceptable, and there is no limit to the number of prints which may be submitted by any one individual.

Section Q (Education) especially desires that reports of research evaluating the educational product of the present generation as compared with earlier ones be presented at the Chicago meetings. A limited number of papers on other topics will be considered. Those wishing to submit papers should send them to D. A. Worcester, Secretary of the Section, University of Nebraska, Lincoln 8, Nebraska.

About People

H. J. Muller, professor of genetics, University of Indiana, and Nobel Prize winner in physiology and medicine, has been elected a trustee of the Worcester Foundation for Experimental Biology, Shrewsbury, Massachusetts.

Russell A. Huggins, assistant professor of pharmacology, University of Georgia Medical School, has been appointed associate professor of pharmacology, Baylor University College of Medicine, and will assume his duties there on July 1.

Wendell F. Hess, head of the welding laboratory, Rensselaer Polytechnic Institute, has been appointed head, Department of Metallurgical Engineering, to succeed Matthew A. Hunter, who will continue as dean of the faculty.

Dennistoun W. Ver Planck, professor of electrical engineering, Carnegie Institute of Technology, has been appointed professor of mechanical engineering and head, Department of Mechanical Engineering, effective September 1. Dr. Ver Planck will assume the position last held by Willibald C. L. Trinks, who retired in 1943.

Stanhope Bayne-Jones has resigned as professor of bacteriology, Yale University, and director, Board of Scientific Advisers, The Jane Coffin Childs Memorial Fund for Medical Research, to become the first president of the Joint Administrative Board, New York Hospital-Cornell Medical Center. After July 1 Dr. Bayne-Jones will maintain offices at 525 East 68th Street, New York City.

Alfred Gilman, College of Physicians and Surgeons, Columbia University, gave the annual Alpha Omega Alpha Lecture at Western Reserve University School of Medicine, on the topic, "The Contributions of Chemical Warfare Research to Medicine."

Edward U. Condon, director, National Bureau of Standards, and **Detlev W. Bronk,** chairman, National Research Council, have been appointed members of the scientific advisory committee of the Brookhaven National Laboratory.

Howard S. Gardner, associate professor, and chairman, Department of Chemical Engineering, University of Rochester, has been appointed director of research and development, Fibreboard Products, Inc., San Francisco. Dr. Gardner will head the firm's new Research and Development Division to be established in Antioch, California.

Russell E. Teague has been assigned to the Henry Phipps Institute of the University of Pennsylvania by the Tuberculosis Control Division of the U. S. Public Health Service, where he will serve as assistant director of the Institute and assistant professor of public health in the University. Dr. Teague will continue as consultant on tuberculosis for District No. 1, U. S. Public Health Service.

Visitors to U. S.

E. C. Marais, of the National Physical Laboratory (South African Council for Scientific and Industrial Research), arrived in Washington, D. C., June 16. Dr. Marais is to work at the National Bureau of Standards.

Alan Robertson, of the Agricultural Research Council's National Animal Breeding Research Organization, and Mrs. Robertson are visiting the United States. Dr. Robertson, traveling under a research fellowship, will study the latest techniques in animal genetics.

T. Goodey, Institute of Agricultural Parasitology, London School of Hygiene and Tropical Medicine, has arrived in the United States to spend three months observing U. S. research in nematology. Dr. Goodey is visiting this country on a traveling research fellowship awarded by the Ministry of Agriculture.

E. T. Jones, of the Welsh Plant Breeding Station, will visit the United States and Canada under a Ministry of Agriculture traveling fellowship to study application of newer techniques of plant breeding.

Colleges and Universities

Massachusetts State College, Amherst, in May became the University of Massachusetts. This change in name is the third since the institution was founded in 1863. On the 700-acre campus in Amherst are five schools and three divisions in the undergraduate college, a graduate school which has been organized as a separate unit since 1908, and a two-year school of agriculture. A $3,000,000 building program, now in progress, includes new dormitory projects, a new physics building, a school of home economics, an animal pathology laboratory, and classroom buildings.

Charles University, Prague, Czechoslovakia, has opened a new Department of Parasitology and Protozoology which is headed by Otto Jírovec. The Department, located at Praha II, Viničná Nr. 7, has published 10 scientific works in Czech, Swiss, and English journals since the end of the war. At present, research work is being done on the chemotherapy and epidemiology of *Trichomonas vaginalis* and on the epidemiology of Leptospirosis. In addition, the Department may be called upon for all diagnostic work on parasitic diseases of the country. Dr. Jírovec reports that the Department still lacks modern parasitological literature and would appreciate receiving such literature, especially in the form of reprints.

Meetings

Centenary Celebrations of the Chemical Society, London, the oldest chemical society in the world, will be attended on July 15–17 by representatives of about 20 countries. The American Chemical Society, the world's largest, is sending as its official delegates its president, W. A. Noyes, Jr.; its president-elect, C. A. Thomas; and its secretary, A. H. Emery. Also representing the United States will be Marston T. Bogert, president of the International Union of Chemistry, and Linus Pauling, one of the Society's Honorary Fellows.

The Tri-State Field Conference, participants in which are the staff members and graduate students of the various universities, colleges, and State Geological Surveys in Wisconsin, Iowa, and Illinois, will be held early in October. W. H. Twenhofel, professor of geology, University of Wisconsin, will lead the group on a two-day trip through the Silurian of eastern Wisconsin. Further information may be obtained through L. M. Cline, Department of Geology, University of Wisconsin, Madison 6, Wisconsin.

The annual Field Conference of Pennsylvania Geologists, held at Lehigh University May 30–June 1, was attended by about 80 geologists from Pennsylvania and neighboring states. An afternoon field trip was conducted on May 30 by Lawrence Whitcomb and H. R. Gault to the abandoned zinc mines of the Saucon Valley and to an area of Triassic basic intrusives south of Bethlehem. On May 31 the Conference participated in an all-day field trip up the valley of the Lehigh River. This trip, led by Bradford Willard and Lawrence Whitcomb, covered the entire Paleozoic sequence from the pre-Cambrian into the coal measures. In addition to the stratigraphic sequence, the physiographic and structural features were discussed and a visit was made to Wild Creek Reservoir, which supplies the water for the City of Bethlehem.

Two alternate trips were offered on the morning of June 1. Prof. Willard led a party to the Delaware Valley to observe the Triassic fanglomerates and their relation to the Paleozoics there, while Prof. Whitcomb conducted a trip to the Spitzenberg, about 25 miles west of Bethlehem, for the purpose of observing its peculiar stratigraphy and discussing its bearing upon certain physiographic problems.

A dinner was held at the University on the evening of the 31st. At a business meeting the previous evening, it was unanimously voted to accept the invitation of S. H. Cathcart, director of the Pennsylvania Bureau of Topographic and Geologic Survey, to hold the 1948 meeting at Harrisburg.

Bradford Willard, head, Department of Geology, Lehigh University, was chairman of the 1947 meeting.

An International Short Wave Congress, one of the first international medical congresses since the end of the war, will be held in Amsterdam, July 19–24, 1948. Biologists and physicists in the field of short-wave therapy who are interested in submitting papers are invited to communicate with H. Th. Boersma, Secretary of the Foreign Correspondence Department, Meyendelscheweg 2, Wassenaar, The Netherlands. Manuscripts must be in the hands of the principal secretary, Dr. J. Samuels, Weteringschans 73, Amsterdam, before April 15, 1948.

Members of the board responsible for direction of the Congress are: W. Beaumont, London; A. Gjertz, Stockholm; C. Guarini, Naples; D. Kobak, Chicago; W. Kowarschik, Vienna; P. Liebesny, New York; J. Meyer, Paris; L. Rósa, Budapest; J. Saidman, Paris; J. Samuels, Amsterdam; F. Scheminzky, Innsbruck; and E. Schliephake, Würzburg.

Recent Deaths

George Eric Macdonnell Jauncey, 58, professor of physics, Washington University, St. Louis, Missouri, died May 19 at his home in St. Louis. Dr. Jauncey, who had been a member of the physics staff since 1920, was well known as an authority in the field of X-ray scattering.

Alice Cary Atwood, 70, formerly botanical bibliographer, U. S. Department of Agriculture Library, co-author of *Geographical guide to floras of the world* and largely responsible for the development of the Botanical Subject Catalog in the Library, died in Washington on May 20.

Warren H. Meeker, 79, professor and head of the Department of Mechanical Engineering, Iowa State College, from 1907 to 1934, died May 30 in Mary Greeley Hospital in Ames.

Eben J. Carey, 57, dean, Medical School, Marquette University, died June 5 of a liver infection in Columbia Hospital, Milwaukee, Wisconsin.

James Henri Walton, 69, professor of chemistry, University of Wisconsin, since 1919, and a member of the Department of Chemistry since 1907, died June 6 after an extended illness.

Karol Bohdanowicz, 82, director of the National Geological Institute, Warsaw, Poland, died June 7.

Arthur D. Emmett, 68, formerly assistant director, Research Laboratories, Parke, Davis & Company, died of pneumonia June 11, in Jennings Hospital, Detroit, Michigan.

The Naval Engineering Experiment Station, Annapolis, Maryland, has added to its Engineering Council a statistician to advise the director and various laboratory superintendents in the utilization of modern statistical techniques, and to perform statistical analyses as necessary. This program, introduced by Adm. D. H. Clark and having the support of the new director, Capt. W. D. Leggett, Jr., is the first of its kind installed in Bureau of Ships laboratories. Miss Besse B. Day, formerly of the Applied Physics Laboratory, Johns Hopkins University, has been appointed to the position.

The staff of the Philippine Fishery Rehabilitation Program of the U. S. Fish and Wildlife Service left San Francisco, California, early this month aboard the *Spencer F. Baird* and the *Theodore N. Gill*, recently commissioned research vessels. This program, one aspect of the provisions of the Tydings Act (Public Law 370 of the 79th Congress), is designed to continue to June 30, 1950 and will be concerned with biological, oceanographic, and technological problems connected with the revival of the large Philippine fish industry.

Offices and the main laboratories are established in Manila, but a forwarding agent will be maintained in San Francisco. The address of the project will be: % Philippine Fishery Program, U. S. Fish and Wildlife Service, 100 Old Mint Building, Fifth and Mission Streets, San Francisco 3, California.

The scientific program is divided into two main subdivisions, one involving biological and oceanographic studies and another for technological research.

The scientific staff of the biological and oceanographic program includes: Herbert E. Warfel, aquatic biologist, formerly with the Bingham Oceanographic Laboratory, Yale University, in charge of biological and oceanographic investigations; Albert W. C. T. Herre, former curator of Ichthyology, Stanford University, consulting ichthyologist assigned to complete a check-list of Philippine fishes; Joseph Goodman, lately with the Department of Aviation Medicine, University of California School of Medicine, and formerly with the California Academy of Science, oceanographic chemist and chief-of-party on the *Spencer F. Baird*; William E. Wood, recently with the Scripps Institution of Oceanography and formerly with the Woods Hole Oceanographic Institution, physical oceanographer on the *Spencer F. Baird*; Earl S. Herald, lately ichthyologist of Operation Crossroads, U. S. Army, Washington, D. C., and one-time biologist with the California Fish and Game Department, biologist on the *Spencer F. Baird*; Charles B. Wade, until recently district biologist with the Central Valley Fisheries Studies of the U. S. Fish and Wildlife Service, Antioch, California, and one-time curator of Fishes at the Allan Hancock Foundation, University of Southern California, biologist on the *Spencer F. Baird*; Donald E. Kauffman, formerly fisheries biologist with the Salmon Division, Libby, MacNeill and Libby, Seattle, Washington, biologist and chief-of-party on the *Theodore N. Gill*; Ralph E. Jentoff, recently teaching fellow in the Department of Chemistry, University of Washington, Seattle, chemist on the *Theodore N. Gill*; William F. Carbine, formerly biologist with the Michigan Institute of Fisheries Research, Ann Arbor, biologist and chief-of-party in pond-fish research; Gilbert E. Wardwell, formerly with the Waterfowl Depredation Program of the U. S. Fish and Wildlife Service, Sacramento, California, biologist in pond-fish research; and Edward E. Cowles, lately an instructor in chemistry at Aberdeen Junior College, Aberdeen, Washington, chemist in charge of the shore laboratory.

The technological personnel of the program comprises: John A. Clague, formerly manager of the Food Engineering Division, Maxson Food Systems, Queens Village, New York, and biochemist with the National Canners Association, in charge of technological and bacteriological studies; William Hamm, formerly in charge of the Puerto Rico Fisheries Technological Laboratory of the Fish and Wildlife Service and lately with the Boston Laboratory of the same service, in charge of studies on fresh and processed fish; Robert Berueffy, formerly with the Ketchikan Laboratory of the Fish and Wildlife Service, Ketchikan, Alaska, in charge of vitamin and reduction investigations; William Arcisz, formerly in the Fish and Wildlife Service Laboratory, College Park, Maryland, bacteriologist; Arthur C. Avery, recently carrying on food research at the University of Massachusetts, Amherst, assistant in processing studies; Robert K. Pedersen, recently technologist with the State Department of Fisheries, Seattle, Washington, assistant in processing studies; Charles Rogers, formerly with the Feed and Fertilizer Laboratory, University of Massachusetts, assistant in vitamin studies; and Harry Hinkle, formerly with the Market News and Development Office of the Fish and Wildlife Service at San Pedro, California, fisheries economics.

The U. S. Atomic Energy Commission has announced that concentrated Boron 10 is available in a limited quantity for general distribution. Boron 10 will be packaged for shipment in the form of the solid complex boron trifluoride-calcium fluoride. The complex contains 6.9 per cent elemental boron, of which 96 per cent is B^{10}. Approximately 6.5 grams of $BF_3 \cdot CaF_2$ are needed to obtain one liter of BF_3 at normal temperature and pressure (assuming 100 per cent liberation). The boron trifluoride may easily be released as a gas by heating to temperatures above 260°C. in a vacuum. Organic vapors and air released from the complex during heating will be present in the BF_3 and will have to be removed in processing material for use in neutron counters. Information on a process which has proved satisfactory for the distillation of BF_3 from the complex will be available after July 1, 1947.

The price of $BF_3 \cdot CaF_2$ complex is $2 per gram independent of quantity. Shipping charges (express or postage) will be added to the invoice. There is no additional handling fee per shipment. Standard units of 1, 5, 10, and 50 grams have been packaged in glass containers with moisture-proof plastic screwtops.

An allocation of B^{10} may be applied for by submitting a completed "Stable Isotope Request," AEC Form 100, in quadruplicate to the U. S. Atomic Energy Commission, Oak Ridge, Tennessee, Attention: Isotopes Branch. Requests will be carefully reviewed and allocations will be restricted to reasonable quantities for the proposed investigation. Clinton Laboratories, Monsanto Chemical Company, P. O. Box 1991, Knoxville 11, Tennessee, will act as the supplier.

The National Bureau of Standards has developed a new method for isotope separation known as countercurrent electromigration, which makes use of the difference in the ionic mobilities of the isotopes of an element. It has been developed to a point where it can be used as a practical means of separating ionic species in general. The main advantage of this method over alternative methods is the simplicity of the apparatus. Isotopic separation takes place in a single step without the need of a vacuum system, and with automatic controls the system becomes entirely self-regulating. The process has the added convenience of being well adapted to use with many elements which may easily be obtained in ionic solutions.

Make Plans for—

Fifth International Pediatrics Congress, July 14–17, Waldorf-Astoria Hotel, New York City.

American Veterinary Medical Association, August 18–21, Cincinnati, Ohio.

American Pharmaceutical Association, August 24, Milwaukee, Wisconsin.

American Society of Mammalogists, August 24–27, Higgins Lake, Michigan.

American Institute of Electrical Engineers, Pacific General Meeting, August 26–29, San Diego, California.

TECHNICAL PAPERS

A Principle for Maintaining Earthworms in Farm Soils

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Ever since the classic work of Darwin (*2*), evidence has been accumulating that earthworms have important physical and chemical effects on soils (*1*, *3*, *5*). This information has not been of much direct use in row-crop farming because practical measures have not been devised for maintaining earthworms on clean-tilled land. In recent studies (*4*) on a Maryland soil, the earthworm population was found to be much lower under annual clean-tilled crops than under sod crops. The reason for this difference has since been investigated, with the purpose of finding a practical means of avoiding the decline in earthworms on annually clean-tilled land.

The investigation was conducted on previously established agronomy plots at the Maryland Agricultural Experiment Station (*4*). Monthly, from February 1946 to January 1947, the earthworms in the plow layer were counted. Table 1 gives the results for plots cropped to corn annually with and without a winter cover and to a two-year rotation in which corn is followed by various legumes and grasses. In plots cropped to corn annually the earthworms increased during the growing season until early November. Between November 23 and December 7 a sudden cold period occurred, and most of the earthworms were killed at this time.

TABLE 1

EARTHWORM POPULATION BY SEASONS IN CONTINUOUS ROW-CROPPING AND IN TWO-YEAR ROTATIONS

Season	Earthworms (thousands/acre)		
		Two-year rotation	
	Corn annually	Sod in spring, corn in summer, wheat in fall	Wheat in spring, sod in summer and fall
Early spring	60	290	85
Late spring	140	290	80
Summer	125	300	75
Early fall	240	440	305
Late fall (after freeze)	85	85	355
Winter	80	60	320

During this cold period many of the earthworms in the rotation plots containing young wheat also died. In the rotation plots that contained a sod of wheat stubble plus legumes and grasses, the earthworms survived.

At a nearby weather station, a minimum air temperature of 8° F. was reached at this time. On land that was bare or contained young winter wheat, the soil froze to a depth of about 4 inches; but under the sod, and in other plots covered with straw mulch, no freezing occurred. When the plots were resampled between December 4 and 10, numerous dead earthworms were found in those with frozen soil.

TABLE 2

CHANGE IN BODY WEIGHT ACCORDING TO SOIL TEMPERATURE

Soil temperature (°F.)	Change in body weight (%)
32	−100
36	+3
40	−6
50	−15
55	−6
60	−22
70	−19
80	−58

The response of earthworms to temperature was checked further in the laboratory. Earthworms from a sod field were placed in jars of soil having 40 per cent moisture content. The jars were kept at various temperatures in cold storage chambers. The earthworms did best at 36° F., as judged by changes in body weights, but died at 32° F. (Table 2). In a subsequent test in which earthworms from the various agronomy plots were subjected to a temperature of 32° F., all died, regardless of the plots from which they had been taken.

TABLE 3

EFFECT OF SURFACE PROTECTION ON WINTER SURVIVAL OF EARTHWORMS

(January 21, 1947)

1946 crop	Type of surface protection	Earthworms (thousands/acre)
Corn	None	0
	Burlap	995
Corn	None	0
	Lespedeza mulch	1,610
Soybeans	Light residue	335
	Heavy residue	665

These observations indicate that the death of earthworms on the clean-tilled land in the late fall was induced by the sudden drop in temperature to below 32° F. According to observations on three of the plots, this harmful effect can be alleviated by surface protection. These plots were almost bare except for small areas that had been protected with surface coverings of lespedeza hay, soybean residue, and burlap, respectively. The earthworms under the coverings withstood the cold and were highly active (Table 3).

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[1] The collaboration of Homer T. Hopkins, formerly associated with this project, is acknowledged with pleasure. Aggregate analyses were made by Jay C. Bryant.

Various practical ways of protecting the soil surface against sudden drops in temperature in the late fall may be suggested. Threshing residues, chopped corn stalks, composts, or manure might be spread early in the fall after the row crop has been removed. Where these materials are not available, a fast-growing catch crop that forms a winter mulch might be interseeded at the last cultivation of the row crop.

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Distribution of C^{14} in Photosynthesizing Barley Seedlings[1]

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As part of a program for the biosynthesis of carbon-labeled biologically important compounds, especially sugars, the following exploratory work has been performed on the assimilation of radioactive carbon dioxide in the light by young barley plants.

Plants were grown in a greenhouse on Hoagland's nutrient solution until they averaged 6–7 inches in height. Upon removal to the laboratory, select plants were divided into two groups: (1) those from which primary and secondary roots and hypocotyl had been cut (hereafter referred to as "minus"); and (2) entire plants, except for secondary roots (hereafter referred to as "plus"). Fresh weights of each group were approximately equal. (The minus group therefore had considerably more leaf material, since the roots and hypocotyls of the plus plants constitute a large fraction of their weight.)

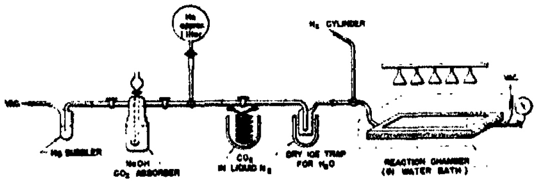

Fig. 1

The reaction chamber housing both groups of plants consisted of a rectangular brass frame sandwiched between two 1-inch glass panes; the free volume was approximately 1 l. The chamber was placed within a tank containing flowing water for cooling (ca. 25°) and illuminated from above, at a distance of 18 inches, with a bank of four GE Projector Spot, 250-watt lamps.

The setup in the experiment is depicted in Fig. 1. The CO_2 absorber, filled with NaOH, was present to catch any CO_2 escaping the spiral immersed in liquid nitrogen. The helium (or H_2) bulb, containing 2–5 p.s.i. (above atmospheric pressure) of the gas, flushed the spiral containing $C^{14}O_2$ into the chamber. At the beginning and end of the experiment, hydrogen flushed other gases out of the tissue. The dry ice trap was for water.

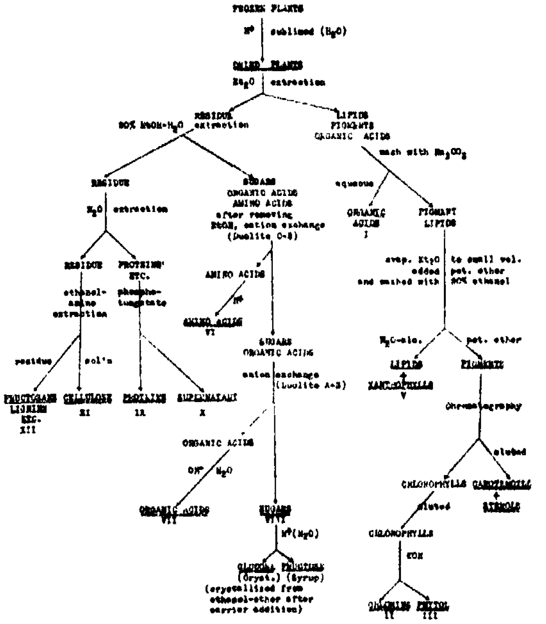

Fig. 2. The substances doubly underlined are materials upon which direct counts were obtained; those singly underlined, materials whose activity was obtained by difference.

TABLE 1

	With roots Total activity fixed (%)	Without roots Total activity fixed (%)
Dried whole plant	100*	100†
Ether extractable acids (I)	[12.5]‡	[7.9]‡
Chlorins (II)		0.8
Phytol (III)		0.9
Carotenoids (IV) (contaminated with sterols)	6.1 0.9	3.6
Other lipids (V)		
Amino acids (VI)	7.2	5.6
Acids (VII)	11.3	7.7
Sugars (VIII)	25.8	35.0
Soluble protein (IX)	0.7	6.9
Nonprotein (aqueous) (X)	[3.5]‡	
Cellulose (XI)	2.8	3.6
Lignins, etc. (XII)	[8.3]‡	[9.4]‡
	78.2§	79.7§

* The weight was 2.223 grams—containing 2.00 × 10^6 c/min.

† The weight was 1.871 grams—containing 0.58 × 10^6 c/min.

‡ Obtained by calculation rather than direct measurement.

§ Much of the loss is due to incomplete recovery of acids from regenerated adsorption columns.

The chamber was filled with hydrogen and evacuated 5 successive times to remove CO_2, after which the $C^{14}O_2$ (from approximately 45 mg. of $BaC^{14}O_3$) was swept in with the aid of helium to a vacuum of 23 inches, and finally, hydrogen was admitted to a vacuum of 5 inches. The light was then turned on, and the leaves permitted to photosynthesize for 60 minutes. At the end of the experiment the chamber was slowly evacuated, the remaining CO_2 being caught in the spiral and NaOH bubbler. Six flushings with hydrogen to remove as much CO_2 as possible, the final evacuation being to ca. 29 inches, consumed an additional hour. The respiration time was therefore two hours.

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[1] This paper is based on work performed under Contract #W-7405-Eng-48 of the Atomic Energy Commission with the University of California, Berkeley.

[2] With the technical assistance of G. A. Hall.

The plants taken from the chamber were placed immediately into liquid nitrogen and ground to a powder. The frozen powder was then treated as shown in Fig. 2.

The crystalline glucose was obtained by evaporating the hydrolyzed sucrose mixture to a syrup, dissolving this syrup together with several hundred milligrams of carrier glucose in the minimal amount of 95 per cent alcohol, and then adding ether to produce a slight cloudiness. Upon cooling, glucose crystallizes out.

It should be remembered, however, that the above distribution of activity is valid only for the specific set of conditions for photosynthesis given. It may be expected to be different for other conditions, *i.e.* time, O_2 pressure, CO_2 pressure, etc.

The activity measurements of the various fractions shown in the foregoing chart are given in Table 1.

IN THE LABORATORY

A Micromethod for the Determination of 1−(+) Lactic Acid[1]

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Lehmann (*2*) has presented a detailed description of a simple micromethod for determining 1−(+) lactic acid which appears to have been largely overlooked. We have found this basic method very useful and have devised certain modifications which eliminate interfering substances and permit final measurement to be made colorimetrically.

The method depends on the quantitative oxidation of lactic acid to pyruvic acid by means of the yeast enzyme, lactic dehydrogenase, in the presence of potassium ferricyanide, which acts as hydrogen acceptor. Lehmann titrated the resulting potassium ferrocyanide with ceric sulfate, using 1 per cent "setoglaucin-o" as the indicator. Diphenylamine sulfonic acid may likewise be used (*3*) as the indicator. According to Lehmann, the method is quite specific. Of a group of 52 substances investigated, which included carbohydrates, amino acids, *α*- and *β*-hydroxybutyric acids, intermediary metabolites, and substances related structurally to lactic acid, the only compounds which interfered with the determination were glycolic, *α*-hydroxybutyric, and glyceric acids, *α*-glycerophosphate, hexosediphosphate, and hexosemonophosphate. The first two compounds are not present in sufficient concentration to interfere in biological fluids. The last four can be removed by treatment with $CuSO_4$-$Ca(OH)_2$ according to the method of Friedemann and Kendall (*1*). Ascorbic acid which interferes by reacting directly with potassium ferricyanide can likewise be removed by this procedure. Preliminary treatment with $CuSO_4$-$Ca(OH)_2$ does not interfere with the enzymatic reaction providing the pH is properly adjusted before incubation with the enzyme.

Thus, the procedure used in this laboratory is similar to that described by Lehmann except for the use of $CuSO_4$-$Ca(OH)_2$ for the removal of interfering substances and the determination of potassium ferrocyanide by a colorimetric instead of a titrimetric method. A brief description follows.

Reagents necessary for the method are M/15 Na K phosphate buffer, pH 7.4; 5M/1,000 potassium ferricyanide in water; and ferric salt prepared as follows: Twenty grams of gum ghatti in a cheesecloth bag is soaked in 1 l. of water for 24 hours, and 5 grams of anhydrous $Fe_2(SO_4)_3$ and 75 cc. of 85 per cent H_3PO_4 + 100 cc. of water are added. After mixing, 15 cc. of 1 per cent $KMnO_4$ is added in order to destroy reducing materials in the gum ghatti. The solution is allowed to stand a few days before using.

Fleischmann's baker's yeast is powdered and dried at room temperature. It is then washed several times with distilled water (100 grams in 1 l. of water), following which it again is dried at room temperature and powdered. This dried yeast is the source of the enzyme, lactic dehydrogenase, and keeps indefinitely in the refrigerator. Before using, the yeast is washed once with phosphate buffer (50–100 mg. yeast, depending upon the activity, in 10 cc. of buffer), centrifuged, and resuspended in the same volume of buffer. The activity of the enzyme as well as the removal of intracellular substrate may be tested as suggested by Lehmann by incubating 1-cc. aliquots of the yeast suspension alone, and with 180 γ lactate, in the presence of 1 cc. of a solution of o-chlorophenol-indo-2:6-dichlorophenol (sodium 2,6-dichlorobenzenone-indo-3-chlorophenol (ortho), Eastman P 3467) (1:50,000) in an open test tube. In the presence of lactic acid the indicator should be decolorized in 3 minutes or less. The control should not be decolorized in 10 minutes and usually is not in an hour.

Procedure: The sample containing lactic acid is deproteinized with trichloracetic acid and centrifuged. The supernatant fluid is neutralized and diluted so that 1 cc. contains not more than 200 γ of 1-lactic acid. If ascorbic acid or phosphorylated hexoses be present, the sample is treated with $CuSO_4$-$Ca(OH)_2$ as described by Friedemann and Kendall. Treatment with trichloracetic acid is unnecessary when the $CuSO_4$-$Ca(OH)_2$ precipitation is used in unknowns with small amounts of

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[1] This work was supported by a grant from the Mallinckrodt Chemical Works.

proteins. After removal of the $CuSO_4$-$Ca(OH)_2$ precipitate by centrifugation, the sample containing the lactic acid is neutralized. One cc. (containing 200 γ or less) is incubated with 1 cc. of yeast suspension in phosphate buffer and 1 cc. of potassium ferricyanide for ½ hour at 30° in open test tubes. Air does not interfere with the determination. At the end of the incubation period, the mixture is centrifuged. To 2 cc. of the supernatant fluid ferric sulfate solution is added, the mixture is diluted, and the amount of resulting Prussian blue determined using a photoelectric colorimeter with a yellow-green filter. In our experiments the Cenco-Sheard-Sanford photelometer was used. For this instrument we found it best to use two standard curves—one for samples containing less than 75 γ of l-lactic acid/cc., the other for samples containing 75–150 γ. If the sample contains less than 75 γ/cc., 2 cc. of the supernatant fluid from the enzyme mixture are placed directly in a cuvette, 1 cc. of ferric salt solution and 2 cc. of water are added, and the reading made immediately. For samples containing 75–150 γ, 2 cc. of the supernatant fluid from the enzyme mixture are placed in a 10-cc. volumetric flask, 2 cc. of Fe^{+++} salt added, the mixture diluted to volume, and the Prussian blue determined.

A practically straight-line relationship is obtained when per cent transmission is plotted against concentration. The curve is completely reproducible with the same yeast preparation and when incubated for the same length of time. We found it best, however, to make a standard curve with each set of analyses by setting up one blank determination and one with a known amount of lactic acid, in this way correcting for any variation in the yeast suspension or in the procedure.

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Histochemical Demonstration of Alkaline Phosphatase in Decalcified Dental and Osseous Tissues[1]

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Histochemical studies on alkaline phosphatase in bones and teeth have been restricted to the incipient stage of mineral deposition, due to the fact that it very soon becomes impossible to section these structures without first decalcifying them. Employment of acids to remove the mineral has resulted in destruction of this enzyme. In rats, therefore, it has not been possible to follow the alkaline phosphatase in odontogenesis later than 4 days past birth (*1*).

It is obviously desirable to learn the localization and relative activity of this enzyme in bones and teeth throughout their developmental history. It would be expected that such information might have functional significance. The dental tissues are of extraordinary interest in this regard, since they are highly specialized for mineral deposition.

In the development of a method for the successful demineralization of the hard structures without at the same time destroying the alkaline phosphatase, we have been guided by a study of the activity of this enzyme *in vitro* under a variety of environmental and chemical factors (*2*).

The heads of 28-day-old rats were split in the midsagittal plane, fixed in cold, 80 per cent alcohol, and placed in the following solutions of specified pH:

I. (a) equal parts of 20 per cent sodium citrate and 2 per cent formic acid..............pH 4.9
   (b) equal parts of 20 per cent sodium citrate and 5 per cent formic acid..............pH 4.2
II. (a) 5 per cent aqueous ammonium citrate..............pH 4.8
   (b) 10 parts 5 per cent ammonium citrate and 1 part 15 per cent citric acid..............pH 4.2

Completion of decalcification, as shown by the needle test, required 1–5 days. During dehydration of the tissue blocks all alcoholic solutions were buffered to pH 9.3 ± 0.1, a step important in preserving the maximum phosphatase activity. In line with this objective it was found necessary to use a minimum of heat to expand the paraffin ribbon; we allowed 10–15 seconds at 45°–50°C. when using paraffin with m.p. 56°–58°C.

The upper incisors and molars with bony encasements in each case were sectioned longitudinally. The sections were uniformly incubated for 3 hours at 37°C., using sodium glycerophosphate as a substrate. Visualization of the enzymatic action was brought about by the generally accepted method of Gomori (*3*), which results in the formation of black cobalt sulfide at the site of enzyme activity.

The range in hydrogen-ion concentration over which decalcification could be accomplished without destroying alkaline phosphatase was found to be very narrow, *i.e.* pH 4.8–5.0. When this range was exceeded on the alkaline side, the rate of decalcification became unduly slow; with a slight increase in acidity the alkaline phosphatase activity was irreversibly lost. This is illustrated by the observation that little or no phosphatase activity was demonstrable in the tissues decalcified in solutions Ib and IIb at pH 4.2. The phosphatase activity was well preserved, however, in comparable tissue blocks decalcified at pH 4.8 and 4.9 (solutions Ia and IIa, respectively). The purpose in buffering all the alcoholic solutions used subsequent to decalcification was to provide immediately an optimum condition for the phosphatase to retain and perhaps to regain activity. That this may be an important factor was further demonstrated by allowing sections to stand 24 hours in an aqueous medium buffered at pH 9.3 ± 0.1 prior to incubation; there was a definite increase in phosphatase activity in comparison with adjacent sections not so treated and which contained demonstrable phosphatase activity. The reaction was also accentuated by the addition of magnesium chloride to the substrate. In fact, when sections were pretreated in the manner just described and subsequently incubated with magnesium ions in the substrate, an amount of precipitate was deposited in the odontogenic and osteogenic tissues which was considered to represent a maximum alkaline phosphatase reaction.

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[1] Aided by a grant from the Milton Fund, Harvard University.

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